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STATE GEOLOGICAL SURVEY.

Governor C. S. Deneen, T. C. Chamberlain, E. J. James, Commissioners;
H. Foster Bain, Director.

Administrative Report for 1906

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H. FOSTER BAIN.

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Letter of Transmittal.

STATE GEOLOGICAL SURVEY,
UNIVERSITY OF ILLINOIS,
URBANA, Dec. 20, 1906.

Governor C. S. Deneen, Chairman, and Members of the Geological Commission:

GENTLEMEN—I submit herewith my administrative report of the operations of the State Geological Survey for the year November, 1905, to November, 1906, the period corresponding to the first year of our survey work. This report is intended to be accompanied by a series of brief papers summarizing the results of the work of the survey, the whole forming a year-book for general distribution. A number of these papers are now in hand and illustrations for the remainder are being prepared. In order to avoid possible delay as well as to furnish needed extra copies, I would recommend an advance edition of 1,500 copies of this report be printed for immediate use. Accompanying my report upon the geologic work is a brief report on the coöperative topographic survey. A more detailed statement has been courteously prepared at my request by Mr. H. M. Wilson, geographer of the U. S. Geological Survey, who has been in general charge of this portion of the work, and will be separately published.

Permit me in submitting this report to express my high appreciation of the active and untiring interest in the work which has been shown by all the members of the commission.

Respectfully,
H. FOSTER BAIN,
Director.

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Introduction.

History.—The study of the geology and the mineral resources of Illinois began in 1851, the Seventeenth General Assembly having passed an act providing for "A Geological and Mineralogical Survey of the State of Illinois." Under the provisions of this act Dr. J. C. Norwood was appointed State Geologist. He served six years and was succeeded by Dr. A. H. Worthen, who continued in the service of the State up to the time of his death in 1888. Small appropriations were made for the survey, and the publication of its results up to 1875, when the Twenty-ninth General Assembly failed to make an appropriation. The succeeding assembly in 1877 provided instead for a State Museum of Natural History, to which the collections of the Survey were transferred at the same time that Dr. Worthen was appointed curator. The museum has since been steadily maintained, though no funds have been available for field work.

In 1905 the Forty-fourth General Assembly provided for a resumption of field work under the following law:

An Act *to establish and create, at the University of Illinois, the bureau to be known as a State Geological Survey, defining its duties and providing for the preparation and publication of its reports and maps to illustrate the natural resources of the State, and making appropriation therefor.*

Section 1. *Be it enacted by the People of the State of Illinois represented in the General Assembly:* That there be and is hereby created and established at the University of Illinois a bureau, to be known as a State Geological Survey, which shall be under the direction of a commission, to be known as a State Geological Commission, composed of the Governor, who shall be *ex-officio* chairman of said commission, the president of the University of Illinois, and one other competent person to be appointed by the Governor, who shall hold office for the term of four years and until his successor is appointed and qualified.

§ 2. The said commissioners shall serve without compensation, but shall be reimbursed for actual expenses incurred in the performance of their official duties; and said commissioners shall have general charge of such bureau and shall appoint a director, who may, with the approval of the board, appoint such assistants and employès as may be necessary to carry out the provisions of this Act.

§ 3. The director appointed under the provisions of this Act, and the assistants and employès appointed by him, as hereinbefore provided, shall receive such salaries or compensations as may be determined by the board of commissioners.

§ 4. The said bureau shall have for its objects and duties the following:

(1) A study of the geological formations of the State with special reference to its products, i. e., coals, ores, clays, building stones, cements, materials for use in the construction of roads, gas, mineral and artesian water and other mineral resources.

(2) The preparation of geological and other necessary maps to illustrate the resources of the State.

(3) The preparation of reports, with necessary illustrations and maps which shall include both a general and detail[ed] description of the geological and mineral resources of the State.

(4) The consideration of such other scientific and economic questions as in the judgment of the commissioners shall be deemed of value to the people.

§ 5. The regular and special reports of said bureau shall be printed and distributed and sold, as the commissioners shall deem best for the interest of the people of the State, and as they may direct; and all moneys obtained by the sale of said reports shall be paid into the State Treasury.

§ 6. The printing of said reports and of the necessary supplies of stationery, blank books and other printed matter necessary for the purpose of said bureau shall be and form a part of the State printing contract, and as such be under the direction and supervision of the Board of Commissioners of State Contracts; *provided, however*, that the cost thereof shall not exceed the sum of five thousand (5,000) dollars per annum.

§7. The director[s] shall present to the Governor an annual report showing the progress and condition of said bureau, together with such other information as the commissioners may deem necessary and useful.

§ 8. All materials collected, after having served the purpose of the bureau, shall be distributed by the director to the educational institutions of the State in such a manner as the commissioners may determine to be of the greatest advantage to the educational interests of the State, or, if deemed advisable, the whole or part of such material may be placed on permanent exhibition in the State Museum of Natural History at Springfield, or in the museums of the University of Illinois.

§ 9. The sum of twenty-five thousand (25,000) dollars per annum or as much thereof as may be necessary is hereby appropriated out of any money in the State Treasury, not otherwise appropriated, to provide for the payment of actual expense incurred by the said commissioners in the performance of their official duties hereunder, and for other expenses or obligations authorized by them, and for the payment of the salary of the director appointed by said commissioners, and for the payment of salaries or other compensations of the assistants or other employès that may be appointed hereunder; and the Auditor of Public Accounts is hereby authorized and instructed to draw his warrant on the treasury for the allowance of said expenses and salaries upon the presentation of proper vouchers approved by the Governor.

§ 10. The said commissioners are hereby authorized to arrange with the director or the representatives of the United States Geological Survey in regard to coöperation between the said United States Geological Survey and the said Geological Commission in the preparation and completion of a contour topographic survey and map or maps of this State, and said commission may accept or reject the work of the United State Geological Survey.

§ 11. In order to carry out the provisions of this Act it shall be lawful for any person or persons employed hereunder to enter and cross all lands within this State; *provided*, in so doing no damage is done to private property.

§ 12. The commission may expend in the prosecution of such coöperative work a sum equal to that which shall be expended thereon by the United States Geological Survey; *provided*, that not more than ten thousand (10,000) dollars be expended in this work in one year.

§ 13. That it shall be the duty of the University of Illinois to give thorough and reliable instruction in the geology of the clay working materials; their origin, classification, physical and chemical properties, and their behavior under such influences as are met with during the process of manufacture; and to provide for this purpose such instructor, laboratories, apparatus, and all illustrative material as may be necessary to make this instruction practical; and to carry out the provision of this section there is hereby authorized the sum of five thousand (5,000) dollars annually, and the Auditor of Public Accounts is hereby authorized to draw his warrants on the State Treasurer for the sum appropriated in this section upon order of the chairman of the Board of Trustees of the University of Illinois, countersigned by the secretary and with the corporate seal of the University.

§ 14. All previous enactments which conflict with the provisions of this Act are hereby repealed.

Approved May 12, 1905.

Personelle.—Pursuant to this law the commission was organized by the appointment of Prof. T. C. Chamberlin of Chicago as the third member, and in September the present director was elected. He assumed office Nov. 1, 1905. A short time later the following additional appointments were made:

Prof. C. W. Rolfe, Consulting Geologist in Clay Investigations.
Prof. R. D. Salisbury, Consulting Geologist in Preparation of Educational Bulletins.
Prof. U. S. Grant, Consulting Geologist in Lead and Zinc Work.
Prof. S. W. Parr, Consulting Chemist in Coal Investigations.
Dr. Edward Bartow, Consulting Chemist in Water Investigation.
Dr. Stuart Weller, Geologist.
Dr. W. W. Atwood, Geologist.
Prof. J. A. Udden, Geologist.
Mr. R. C. Purdy, Ceramist.
Mr. F. B. Van Horn, Assistant Geologist.
Mr. A. W. Lewis, Assistant Geologist.
Mr. H. B. Fox, Assistant Geologist.
Mr. F. F. Grout, Assistant Chemist.

All of the above appointed promptly entered upon the discharge of their duties, and all are now connected with the survey with the exception of Messrs. Lewis, Atwood, and Grout. Mr. Lewis resigned April 1 to conduct iron ore explorations in Canada. Mr. Atwood left July 1 to take up coal investigations in Alaska in connection with the United States Geological Survey, and Mr. Grout resigned in August to accept a position at Oklahoma University. Mr. W. F. Wheeler has been appointed in Mr. Grout's place. The other positions have been filled by temporary employès.

In addition to the above regular employès the following persons have been employed temporarily in the work of the survey:

Prof. W. S. Blatchley, State Geologist of Indiana.
Mr. E. T. Hancock, Michigan College of Mines.
Mr. H. H. Barrows, University of Chicago.
Mr. J. C. Carman, University of Chicago.
Dr. J. W. Goldthwait, Northwestern University.
Mr. M. J. Perdue, South Bend, Ind.
Dr. N. M. Fenneman, Wisconsin University.
Mr. J. C. Jones, University of Illinois.
Mr. Frank DeWolf, U. S. Geological Survey.
Mr. E. M. Scheflow, Elgin, Ill.
Mr. Jon A. Udden, Rock Island, Ill.
Mr. J. J. Rutledge, Baltimore, Md.
Mr. Tom Moses, Springfield, Ill.

A number of the State Mine Inspectors have also from time to time performed voluntary service in connection with the survey, and a large number of individuals, as shown by Mr. Wilson's special report, have served in the topographic work. In the office Mr. F. G. Nolte and Mrs. Sadie B. Van Horn have served as clerks, while Messrs. D. F. Higgins, A. W. Harris and Guy R. Shaw have worked as draughtsmen.

Organization.—In the organization of the Survey two major lines of work have been recognized, topographic and geologic. As was contemplated by the act establishing the Survey, the topographic work has been carried on in coöperation with the U. S. Geological Survey under the general supervision of Mr. H. M. Wilson, geographer of the U. S. Geological Survey, in charge of the Eastern Division of Topography, and under the immediate direction of Mr. C. E. Cooke in 1905, and in 1906 under Mr. W. F. Herron, topographer in charge of the Central Section.

At the beginning it was decided that the geologic work should be temporarily concentrated upon a study of the coals and clays of the State, these being its most important mineral resources. Provision was made for a small amount of work in connection with water, oil, lead, and zinc, and general stratigraphy with a view to later expansion. It was not found practicable with funds available to make any investigation of the cement materials or any other than a most general study of the quarry products and miscellaneous non-metallic minerals. Additional funds are urgently needed for this work.

Material and Subjects Investigated:

Something of the range of the survey work is indicated by the accompanying map upon which is marked the localities from which samples have been taken for analysis or other laboratory tests. A considerable number of different samples were taken from many of the localities noted. No account has been taken in preparing this map of general lithologic samples or collections of fossils made for office study. In the following pages are brief notes of what has been attempted in each case.

COAL.

The study of the coal and coal fields of the State has been carried on both in the field and office. The work has been directed toward—

(1) The solving of problems of stratigraphy such as the distribution and correlation of various coal beds, together with the collection of all data relating to the origin and the mode of deposition of the coal and accompanying beds.

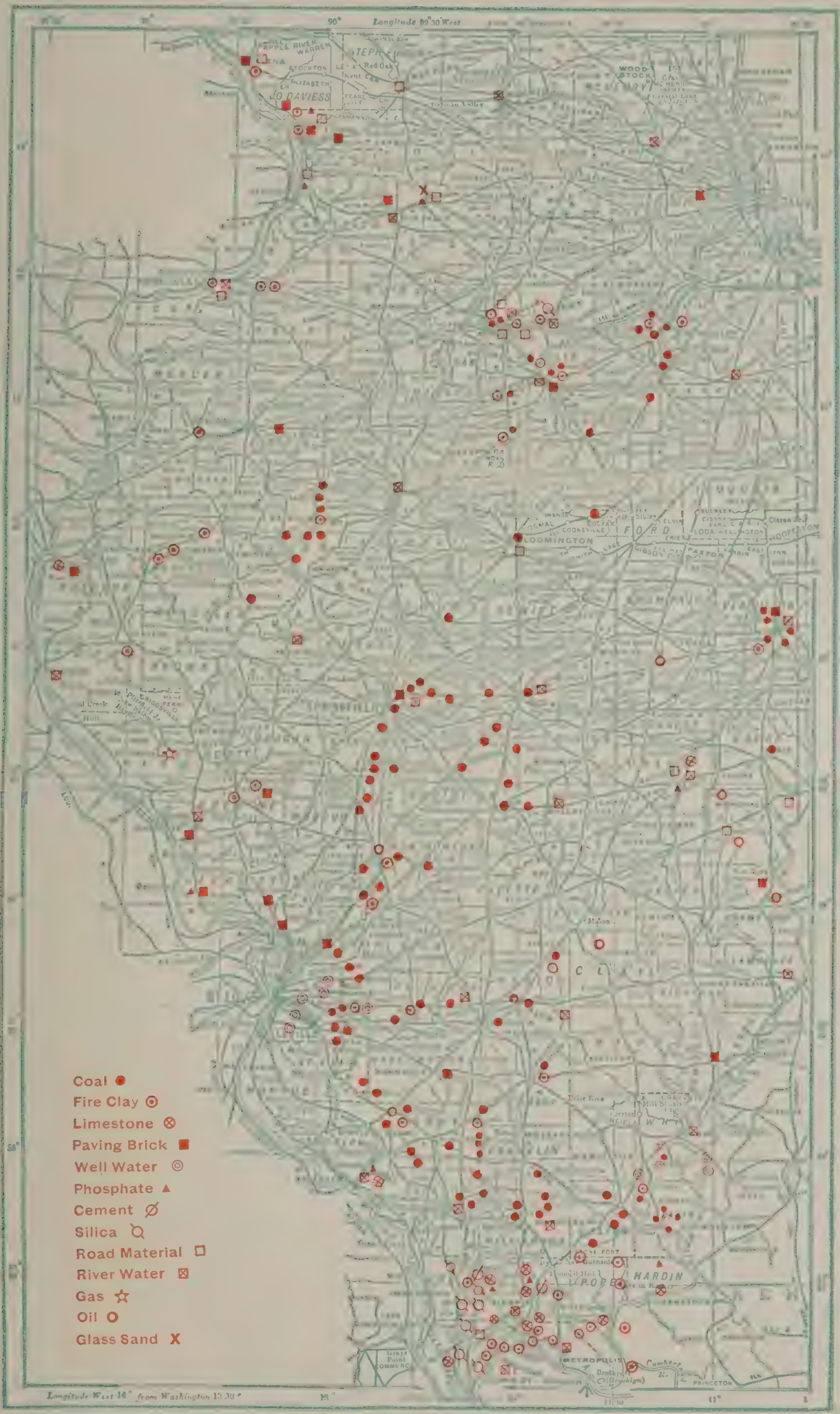
(2) A study of the composition and uses of coals.

(3) A study of the mode of occurrence of coal as relates to the methods and costs of mining.

(4) A study of the preparation of the coal for the market, its transportation, its normal markets, and the competition which it meets.

Progress has been made mainly along the first two lines. In the case of the last two little has been done beyond the determination of the need of such work, its proper scope and the methods to be employed.

Stratigraphy.—A considerable portion of the funds of the survey have been devoted to stratigraphic studies of the coal measures, as is shown by the statement of expenditures given on the succeeding page. This was done because a thorough knowledge of the stratigraphy of the field is essential to its economical development, and for the further reason that money so spent advances the study of the associated clays, limestones, cement materials, water, and other minerals as well as coal.



Map showing localities from which samples have been collected for analysis or test.

The stratigraphic work is fundamental, and any investigation of more than limited or temporary usefulness must be founded upon an accurate and adequate study of the stratigraphy.

In order to reduce as much as possible the cost of this work to the State, an informal agreement has been entered into with the U. S. Geological Survey for coöperation. This takes the form of simultaneous studies by the two organizations of different parts of the field with exchange of results. Under this arrangement Mr. T. E. Savage, of the State Survey, made a detailed study of the Springfield quadrangle, and Prof. J. A. Udden, assisted in part by Mr. Jon A. Udden, of the Peoria quadrangle. In this work State Mine Inspector James Taylor served as volunteer assistant and contributed greatly to the practical character of the work.

On behalf of the U. S. Geological Survey, Mr. Frank W. DeWolf in July took up the study of the New Haven and Eldorado quadrangles in the southern part of the State. It is proposed to extend these surveys west to cover the whole of rapidly growing southern Illinois coal fields. Mr. David White, of the U. S. Geological Survey, took up the general study of the stratigraphy of the coal measures as shown by the fossil plants, and Dr. Stuart Weller, of the State Survey, began a similar study of the Carboniferous formations, with especial reference to the distribution of marine invertebrates. Both Mr. White and Dr. Weller served with the State and federal field parties without distinction, and it is believed that this careful study from both points of view will be productive of extremely valuable results. The general nature of the work done by Mr. White and something of his results is told in a brief report submitted for the year-book.

In further coöperation with the U. S. Geological Survey a detailed study of the St. Louis-East St. Louis area was also made. Geological formations do not respect state boundaries, and to obtain comprehensive results it is often necessary to make surveys of portions of adjacent states. The St. Louis limestone, one of the very important formations in Illinois, has its type locality across the river in Missouri, and the Cheltenham fire clay, although having extensions in our State, is also best studied in the city of St. Louis. We were therefore fortunate in being able to join the U. S. Survey in a simultaneous study of both sides of the river at this point. This work was under the immediate charge of Dr. N. M. Fenneman, of Wisconsin University, acting for the U. S. Survey, but was participated in by Messrs. Weller, Jones and Purdy, of the State Survey, and White of the federal organization. The expenses of the work were divided between the two surveys. A brief preliminary statement of the results has been prepared and will be published in the year-book.

As a first step in the correlation of the various coal beds, maps have been collected showing the correlations now made by different engineers familiar with the field. Such a map, courteously prepared for us by Mr. A. Bement, of Chicago, was published in our Bulletin 3 to serve until such a time as our own studies would permit the expression of opinion.

Composition and Uses of Coal.—Investigations along these lines have been taken up in coöperation with the Department of Applied

Chemistry and the Engineering Experiment Station of the University. The chemical work has been done under the direction of Professor Parr and has been directed to a study of both the ultimate and proximate composition of coals. As a first step in the work Professor Parr has brought together such existing analyses of Illinois coals as seemed reliable, and has prepared a preliminary report forming Bulletin No. 3 of the present series. In this bulletin the results of 150 analyses of Illinois coals are compared. An interesting result of this work has been the development of the fact that a considerable portion of the volatile matter of the coal as ordinarily determined has really no heat value. This is a fact of considerable economic as well as scientific importance. Professor Parr has also developed a new classification of coals which seems likely to prove widely applicable and of considerable usefulness.

The analyses used in this preliminary work were not made upon samples collected by our own men according to any uniform method. It is accordingly impossible to say how accurately they represent the facts of our coal field. For this reason a whole new set of samples have been collected preparatory to further studies. The new samples have been cut in the mine from a clean face of coal, taking the entire workable thickness of the bed and marking on an accompanying section all partings included as well as rejected in samplings. The samples were promptly quartered down and shipped in an air-tight galvanized iron can so as to arrive in the laboratory without loss or gain in the natural moisture. Whatever additional sampling may prove later to be necessary, it was thought that the first step must be the careful determination of the composition of coal as it is in the ground. Messrs. Grout, Rutledge, Lewis and De Wolf have taken samples according to this method in various parts of the State. In this work we have had the valuable assistance of Mr. Tom Moses, Secretary of the State Mining Board, who served as volunteer assistant. In all 166 are now available for study. It is proposed to increase the number as opportunity serves.

The coal samples have been powdered and prepared, and results of proximate and ultimate analyses, as well as B. T. U. determinations, run on both the Parr and Mahler calorimeters, are now available for the first twenty-five. Professor Parr has prepared a paper discussing these results, which will be separately submitted.

A somewhat similar line of investigation, the effect of weathering on the fuel value of coals, has been also taken up. A number of tests are being run to determine the amount of oxidation and of decomposition which takes place in coal exposed for a series of months under various conditions. It is hoped that these, when checked by studies of the amount of mechanical disintegration, may afford data upon which a proper system of coal storage may be founded.

In connection with the Engineering Experiment Station a study of washed coals has been begun. It is felt that better preparation of coal for the market is a matter of supreme importance, particularly to the extent that it may reduce the amount of smoke made in burning. The Engineering Experiment Station has under way a series of boiler trials on the same coal washed and unwashed, and the Survey is co-operating with the Station in this work.

Mode of Occurrence.—To a very important degree, the mode of occurrence of the coal and the character of the roof shales and floor clay determine the method of mining and the cost of the work. Thorough studies along these lines are highly desirable. A beginning has been made in connection with the work of sampling the veins and the stratigraphical work already discussed. At Peoria Professor Udden and Mr. Taylor have made detailed studies of the puzzling series of faults which have interefered seriously in places with mining. At Springfield the horsebacks have been investigated by Mr. Savage, and at other points in the State similar phenomena have been under view. A much more thorough and complete investigation should be undertaken, and undoubtedly would be productive of results of value. One phase of the subject of pressing importance is the occurrence of gases in mines and their influence in causing and extending explosions. The loss of life and property as a result of explosions in the coal mines is a constant and serious burden. In the six years ending June 30, 1906, 869 lives were lost in our mines. Of these 226 were due to explosions of one sort or another. There should be a thorough and comprehensive investigation of the entire subject to the end that proper precautions may be adopted to prevent or minimize this loss. As a larger number of deep mines is opened in the State it is to be expected that more gas will be encountered, and preparations should be made to meet these conditions.

Markets.—The study of the marketing of our coals is only incidentally a part of the survey work, but it is one of great importance and may be made of the greatest value to the State. For some years the capacity of our mines has been ahead of the demand, and with the increasing demand for smokeless fuel eastern coals have cut into the markets naturally belonging to Illinois. Much good can be done by disseminating correct information regarding methods of burning so as to produce the minimum of smoke. Probably also good results would follow a careful study of the particular demands of our natural markets as regards size of coal. To the extent that it may prove possible it is proposed that the Survey shall assist in this work.

CLAY.

The investigation of the clays has been carried on in connection with the Department of Ceramics of the State University, Professor C. W. Rolfe serving as Consulting Geologist and Mr. R. C. Purdy as Ceramist. Associated with them were Messrs. J. F. Krehbiel, J. K. Moore, A. J. Ellis, H. L. Bushnell, C. E. Merry, and others. Professors A. N. Talbot and Ira O. Baker undertook portions of this work. The chemical work was done under the direction of Professor Parr by Messrs. F. F. Grout, Deane Burns, A. L. Sholb and David Klein.

The principal work of the year has been a study of paving brick clays. This has involved visits to all the paving brick plants of the State, with a study of their processes and the thorough testing of samples of their products. In addition barrel samples of the clay have been shipped to the laboratory, prepared and burned under known conditions and results noted. For purposes of comparison similar samples of clay and brick from the leading plants in Ohio, Indiana, Missouri and Kansas have been collected and also tested. In the collection of these samples we have had the active assistance of State Geologist Orton, and F. H. Riddle in Ohio, of Professor E. M. Shepard in Missouri, and of State Geologist Haworth and F. J. Campbern in Kansas.

The results of the various tests are now being tabulated and a report on the subject will be ready for printing shortly. The investigations show not only that we have large resources of excellent material in Illinois, but also throw important light upon the technology of paving brick making.

A second line of investigation taken up within the year was a preliminary study of the fire clays of the State. Samples of the Paleozoic fire clays were collected by Messrs. Hancock, Van Horn, Grout, Moses, Rutledge and Fox; while Mr. De Wolf in the course of a reconnaissance of the southern part of the State in May and June, collected numerous samples of the Mesozoic clays. These have been tested in a preliminary way by Messrs. Purdy and Krehbiel, and a report on the subject has been prepared by Messrs. De Wolf and Purdy. It is to be regretted that there was no time for a more thorough study, but it seems advisable to print such data as are available and leave until later a more complete study. In all 46 clays were examined, and of these 39 stood a fire test equivalent to 1670 degrees centigrade or higher, and may accordingly be considered refractory. Many of the remaining may be used in situations where a lower heat is sufficient.

Much more work is needed on the fire clays and in addition the pottery clays, terra cotta clays and various building brick clays demand investigation. Second only to coal our clay working industries are the most important ones founded on our mineral resources. In 1905 the total value of the clay output mounted to $12,392,000, and in 1906 there was a substantial gain.

WATER RESOURCES.

Adequate supplies of pure water for municipal and industrial purposes are becoming harder to obtain year by year. As the population becomes denser this difficulty is likely to increase. Since the distribution and occurrence of water is a geological problem, the Survey has taken up studies designated to throw light upon the resources of water supply. In this work it has coöperated with the State Water Survey, the Engineering Experiment Station, and the U. S. Geological Survey under terms of a general agreement quoted below.

> THIS AGREEMENT, made and entered into this first day of July, 1906, between Charles D. Walcott, director, for and on behalf of the United States Geological Survey, of the first part; Edward Bartow, director, for and on behalf of the State Water Survey of Illinois, of the second part; L. P. Breckenridge, director, for and on behalf of the Engineering Experiment Station of Illinois, of the third part; and H. Foster Bain, State Geologist, for and on behalf of the State Geological Survey of Illinois, of the fourth part.
>
> WITNESSETH: It is hereby agreed that there shall be conducted in the State of Illinois a coöperative survey to determine as hereinafter provided, the character and applicability of the natural waters of said State, during a period of twelve months from July 1st, 1906, and that the parties hereunto subscribed shall contribute to the support of said survey as follows:

By the party of the first part	$3,000 00
By the party of the second part	3,200 00
By the party of the third part	1,000 00
By the party of the fourth part	1,000 00
Total	$8,200 00

1. That all work performed under this coöperative agreement shall be confined to the determination of the mineral and organic constituents in the surface and ground waters of said State, their applicability for use for industrial and domestic purposes, and their pollution by sewage, together with certain experimental work: (*a*) upon the effectiveness of sewage purification plants now installed within the State; (*b*) upon the reaction of different types of water in the production of steam in boilers, with studies of boiler scale corrosion and foaming; (*c*) upon a comparative study of methods for the prevention of the growth of crenothrix and in addition thereto such special studies as may be determined upon by the Board of Control hereinafter designated.

2. That the work performed under this coöperative agreement shall be under the direction of a Board of Control composed of representatives designated by the parties hereunto and until further action by the parties shall be as follows:

For the party of the first part, M. O. Leighton.

For the party of the second part, Edward Bartow.

For the party of the third part, L. P. Breckenridge, Arthur N. Talbot, and Samuel W. Parr.

For the party of the fourth part, H. Foster Bain.

It is hereby understood and agreed that in case of a division of opinion in the Board of Control with reference to the disposition of any of the matters over which said board is placed in control under the terms of this agreement, that each of the parties to this agreement shall be entitled to but one vote.

3. That Edward Bartow is hereby designated as administrative director of the investigations provided under this agreement, and shall have in charge the approval of accounts for disbursement, and shall, with the approval and consent of the Board of Control, engage the services and fix the compensation of such assistants as are required for the carrying on of the work herein provided, with the exception of those assistants especially appointed under this agreement.

4. That a member of the staff of the United States Geological Survey, duly classified by the United States Civil Service Commission, shall be designated to carry on a part of the work provided under this agreement, the nature of which shall be determined upon by the Board of Control, and that said official shall be paid the sum of fourteen hundred (1,400) dollars per year for such services.

5. That the three thousand dollars contributed by the party of the first part to the support of the work provided under this agreement shall be expended, so far as it is possible, for the salary of the member of the staff of the United States Geological Survey, and those of such other assistants as may be designated by the Board of Control, the total amount of such salaries not exceeding the contribution by the party of the first part, and that all accounts be paid by the party of the first part shall be prepared and audited in accordance with the rules and regulations of the United States Geological Survey and of the United States Treasury Department.

6. That thirty-two hundred dollars contributed by the party of the second part and the one thousand dollars contributed by the party of the third part shall be expended for assistance, traveling expenses, clerical work, supplies and equipment, and such other incidental purchases and expenses as may be determined on by the Board of Control with the approval and consent of the representatives of said parties.

Proviso. In view of the fact that the State Board of Health has furnished a bacteriologist, at a salary of $1,000.00 per year, whose services are available for the proposed coöperative investigation, and has agreed that the sanitary engineer of the State Board of Health will collect samples from sewage disposal works, and that the medical inspector will collect water from suspected supplies, the contribution by the party of the second part is made with the understanding that the party of the second part shall be free to make for the State Board of Health, bacteriological and chemical examination of suspected water and of sewage, not to exceed 500 in number.

7. That the one thousand dollars contributed by the party of the fourth part shall be expended as follows: (1) Seven hundred dollars to be expended by and under the direction of said party of the fourth part in conference with the administrative director of these investigations; of which five hundred and fifty dollars shall be devoted to a study of the ground waters of the East St. Louis district, and one hundred and fifty dollars to the collection and transportation of samples of well waters from selected points throughout the State, and to preliminary studies of the water horizons of the State. (2) Three hundred dollars of the money contributed shall be expended by said administrative officer for salaries, chemicals, or incidental expenses of this investigation as he shall deem best.

8. That the party of the second part shall provide a suitably equipped laboratory for chemical and bacteriological work, and that in case it shall be necessary to provide extra equipment for the purposes of the investigations herein specified, the cost of such additional equipment shall be paid from any moneys remaining in the fund not otherwise allotted.

9. That there shall be established along the rivers and at points designated by the Board of Control sampling stations from which there shall be sent daily samples to the laboratory of the State Water Survey at Urbana, such samples to be sent by mail in four-ounce bottles, under the authority of the party of the first part and with the franking privilege accorded to such party by law. That these samples shall be stored for definite periods in such laboratory, and analyses of the composite from each sampling station shall be made at intervals to be determined by the Board of Control. That the determinations to be made upon such composite samples shall be determined by the Board of Control and when not otherwise specified shall be the following: Silica, iron, alumina, calcium, magnesium, sodium, potassium, sulphur trioxide, chlorine, carbon dioxide, turbidity (U. S. Geological Survey standard), suspended matter, and dissolved solids; such determinations to be expressed in parts per million and in ionic form.

10. The samples of ground waters from points designated by the Board of Control shall be sent to the above designated laboratory for mineral analysis, the determinations and expressions of results to be the same as that described in the foregoing section of this agreement, and in addition thereto shall be made such other special determinations for defined purposes as may be agreed upon and directed by the Board of Control.

11. That there shall be carried on special experiments upon the effect of the various Illinois waters upon steam producing boilers which shall include a study of the types of such waters with reference to their reaction in boilers, the methods of analysis and the methods of installation of steam apparatus indicated by the various chemical processes revealed and also the corrosion caused by steam waters together with experiments to show the relation between the composition of the water and its tendency to corrode, foam or cause scale, and such other special work as may from time to time be directed by the Board of Control.

12. That samples shall be collected from the public water supplies of the State for the sanitary analysis, for the purpose of determining the potability of such supplies. Such analyses shall include the determination of bacteria and the presence or absence of bacillus coli communis, according to standard methods promulgated by the American Public Health Association. That similar analyses shall be made of the river water at chosen distances below points of pollution to determine the persistence of contaminating matter, the specific determinations to be made in connection with these investigations to be based upon the special problem in each case and to be designated by the Board of Control. Such investigations shall be extended to private water supplies whenever in the opinion of the Board of Control such analyses are desirable. It is understood and agreed that the work indicated in this section shall apply both to surface and to ground waters.

13. That there shall be maintained a series of experiments upon the best methods of treating water supplies subject to polution of various kinds and to the disorders due to microscopic organisms such as crenothrix, these investigations to be designated as "Experimental Work upon the Treatment of Water," and the extent of the work and the character of the tests shall be determined by the Board of Control.

1. The provisional allotments for the various investigations herein provided shall be made according to the following schedule, it being understood and agreed that in case experience shall show that a change in such allotments will be of advantage to the work, such change may be made by the Board of Control:

Mineral analyses—	
Surface waters	$1,830 00
Ground waters	1,300 00
Boiler waters	1,600 00
Sanitary analyses—	
Surface waters	1,000 00
Ground waters	900 00
Experimental work upon treatment of waters	1,000 00
Incidentals and equipment	570 00
Total	$8,200 00

15. That in case it shall be found previous to the close of the term of this contract that the expenses incurred under this agreement will be greater than the total amount of the fund provided, retrenchment shall be made by suspension, acording to the decision of the Board of Control.

16. That in case the expenses of the work outlined in this agreement should not be as great as the fund provided, adjustment shall be made in the last month of the term of the contract by paying salaries and expenses from the various allotments in such a way that the expenditures of each party hereunto subscribed shall be an equal proportion of the amount contributed by each to the fund.

17. And, be it understood and agreed that the original notes and records of the work performed under this contract shall be kept in the custody of the administrative director and copies thereof issued to the several parties to this agreement upon demand. That each of said parties shall have the right to use any part of the results as may be of value in its special line of work for purposes of publication, but that the publication of the results of the entire series of investigations as a whole shall be reserved to the party of the first part. In the publication of said reports by the party of the first part, the relationship of each party to the report shall be clearly stated, and each party shall be provided with an equitable number of copies thereof to be distributed according to the provisions of any statutes by which either party may be governed.

In testimony whereof, we have hereunto set our hands the date and year first written herein.

CHARLES D. WALCOTT,

Director U. S. Geological Survey, for and on behalf of the party of the first part.

EDWARD BARTOW,

Director State Water Survey of Illinois, for and on behalf of the party of the second part.

L. P. BRECKENRIDGE,

Director Engineering Experiment Station of the University of Illinois, for and on behalf of the party of the third part.

H. FOSTER BAIN,

State Geologist, Illinois State Geological Survey, for and on behalf of the party of the fourth part.

In accordance with paragraph 3 of the agreement, Mr. Isaiah Bowman and Mr. Chester A. Reeds were assigned by the State Geological Survey to summer field work in the East St. Louis Quadrangle. In connection with their study of the area, twenty-four samples of water were sent in to the State Water Survey Laboratory, analyses of which were made by Mr. W. F. Wheeler.

For the collection of daily samples of water, twenty-six stations, as shown on the accompanying sample map, were established in the State during the latter part of July. Samples have been shipped regularly since August first from the following places.

Location.	Stream.	Location.	Stream.
Carlyle	Kaskaskia river	Marion	Reservoir
Carmi	Little Wabash river	Menard	Mississippi river
Cartter	Reservoir	Moline	Mississippi river
Chandlerville	Sangamon river	Mounds	Cache river
Charleston	Emparass river	Murphysboro	Big Muddy river
Cypress	Reservoir	Ottawa	Fox river
Danville	Big Vermilion river	Peoria	Illinois river
Decatur	Sangamon river	Quincy	Mississippi river
Elgin	Fox river	Rock Falls	Rock river
Joppa	Reservoir	Rockford	Rock river
Kampsville	Illinois river	Shelbyville	Kaskaskia river
Kankakee	Kankakee river	Springfield	Sangamon river
LaSalle	Illinois river	Sterling	Rock river
Lawrenceville	Embarass river	Streator	Vermilion river

The detailed study of the water resources of the East St. Louis district were undertaken in June. In a district of so many and such varied manufacturing interests as that extending from Alton to Belleville, water problems are numerous and difficult. The work was begun in coöperation with the Eastern Section of Hydrology of the U. S. Geological Survey, M. L. Fuller in charge, but in June, owing to the decreased appropriations being made by Congress, the entire work was transferred to the State and became a part of the general coöperative work on water as provided in the above agreement. At this time all the notes previously collected were turned over to the State. The report has been finished and illustrations are now being prepared. Many points of interest to the water users were found by Messrs. Bowman and Reeds, and it is believed that their conclusions will prove of large value to the people of the district concerned.

Dr. E. A. Bartow, Director of the State Water Survey and Consulting Chemist to the Geological Survey, has undertaken to prepare a general report upon the nature of the underground waters of the State, as regards their distribution, classification, therapeutic values and uses. This work is now under way. To accompany this Professor J. A. Udden has prepared a chapter on the underground water horizons, but a much more complete discussion of the artesian possibilities of the region is badly needed.

Another line of investigation, which it has been suggested the Geological Survey should take up, relates to the swamp and overflowed lands, the action of rivers, and the methods of drainage. Large areas of land have already been reclaimed by drainage, and many local drainage districts are now in existence. When, however, the problem of the control of a whole river such as the Sangamon, Kaskaskia, Embarass or Little Wabash is approached, it is at once found that the data are not now available upon which to plan a comprehensive and economical system. Numerous stream gaugings are needed, the area of the water shed, the rainfall and the regime of the main river and its tributaries must be studied if the best system of river control is to be adopted. The topographic maps now being made by the survey will afford much of this data, but other material can only be obtained as a result of special study. Land is becoming exceedingly valuable in Illinois, and a wise provision for the future would suggest the reclaiming of every available acre. In order to prevent waste and misdirection in expenditure a certain amount of preliminary study should be devoted to the problem, and at the same time the surveys of the river valleys should be advanced as rapidly as possible. While there have been numerous demands for the survey to take up this work, the director and the commissioners have not felt free to do so, with the resulting diversions of funds from other lines of investigation, and a special appropriation should be provided if the work is to be done.

OIL AND GAS.

Important deposits of petroleum were discovered in southeastern Illinois late in 1904. Shipments began in June, 1905, and by August, 1906, the output had grown to 800,000 barrels for the month, approximately equaling the output of Indiana for the corresponding month of the preceding year. The total output for 1906 will fall but a little below half the output of Indiana for the preceding year. This development has been exceedingly gratifying. Promptly after the organization of the geological branch of the survey steps were taken to make a proper study of this important new mineral resource. Mr. A. W. Lewis spent some time in the field determining its general outline and collecting such well records as were available. In April and May the entire field as then developed was studied for us by Professor W. S. Blatchley of Indianapolis, an experienced oil expert and State Geologist of Indiana. Professor Blatchley's conclusions were most encouraging, and his report, forming Bulletin 2 of the present series, was promptly sent to the printers. In this bulletin the origin, distribution, and methods of producing the oil were discussed in such detail as the then available data would permit. Analyses of representative samples were added, and a list of bench marks given. The latter was based on a series of levels run through the region for the survey by E. M. Scheflow, assisted by Mr. Loren Digby. Some 117 points of accurate elevation were established for use in correlating oil sands and marked by suitable brass tags.

In addition to this discussion of the southeastern Illinois petroleum field, brief notes on oil and gas discoveries in Pike, Montgomery, Randolph, Saline and Williamson counties, written by various other members of the survey, were appended. The oil field has continued to ropidly develop and additional surveys will soon be necessary. The large volume of gas now being found, estimated at 50,000,000 cubic feet per day, also demands investigation. Steps should be taken in particular to prevent its further waste.

EDUCATIONAL BULLETINS.

Following the example of some of the other states, the Geological Survey of Illinois has planned the publication of a series of educational bulletins. They have been called educational, because their purpose is to put useful information concerning the geology and geography of the State, or some parts of it, before those who are not special students of those sciences. More particularly, their purpose is to put into available form such knowledge as will help those who are not geologists in understanding the common phenomena of their own regions. The bulletins are therefore intended to serve the citizens at large, rather than special students of geology, or special industries of the State which depend, directly or indirectly, on the mineral resources. Other and more technical publications serve this later purpose.

Two classes of people are kept especially in mind in the preparation of these bulletins. These are (1) intelligent citizens whose attention, for one reason or another, has never been directed to geology. Among such citizens there are always some one who are interested in understanding their home regions; and through the understanding of one region the general principles of geology are grasped, in some measure at least. The knowledge thus acquired may be a source of much satisfaction to those who possess it. Furthermore, there is always the possibility that occasion may arise in the future when the information can be turned to account in economic ways.

(2) The study of physical geography and geology is now pursued somewhat generally in high schools, and might be pursued with great advantage much more widely than it is now in the country schools. According to the improved methods of study at the present time, it is essential that the subjects studied be so illustrated and applied that the knowledge acquired becomes a part of the student's permanent equipment. His study of physical geography fails of its full purpose unless it puts him into possession of the ability to interpret the surface of the land as he travels to and fro, in after life. The best way to acquire this ability appears to be to make application of principles studied in the school to the phenomena of the region in which the school is located. Many of the principles of physical geography and geology are illustrated within easy reach of most of the schools in the State.

A second purpose of these bulletins, therefore, is to put the schools of the various parts of the State into possession of a general account of the principal geographic and geological features of their regions, which may be used as a sort of field book. This field study in physical geography serves the same purpose as laboratory work in physics and chemistry, in connection with those subjects.

It will be long before all the important regions of the State can be covered in this way. In the choice of areas selected for early treatment, three considerations control. These are the following: (1) Areas of great inherent interest will take precedence over those not so favored. (2) Areas of which topographic maps have been made will take precedence over those not so mapped; and (3) areas where the bulletins are likely to be widely used will have precedence over other areas. The areas which will receive early consideration are the areas where these three conditions are found.

The topographic maps have been made for but relatively small portions of the State, so that, at the present time, the larger part of the area of the State is ruled out of the immediate consideration in this connection.

This work has been placed in charge of Professor R. D. Salisbury of the University of Chicago, Consulting Geologist of the Survey. Five bulletins have been undertaken. One of them has been completed. The field work for three others has been essentially completed, while the work for the fifth is under way. One of the bulletins concerns the region along the shore of Lake Michigan, north of Chicago; a second deals with the valley of the Desplaines river; a third deals with the valley of the Illinois from Hennepin to Pekin; a fourth with the area about East St. Louis; and a fifth (jointly with the Geological Survey of Iowa) deals with the Mississippi valley from Savanna on the north to Davenport and Rock Island on the south.

The first of these bulletins, prepared by Dr. Wallace W. Atwood and Dr. J. W. Goldthwaite, attempts to put into available and popular form present knowledge concerning the geographic development of the region of which it treats. Among other topics it deals with the successive stages in the history of Lake Michigan, and the ways in which the former expanded lake affected the surface.

The second bulletin, by Dr. Goldthwaite, which deals in part with the outlet of the ancestral Lake Michigan, is closely connected with the first, but deals with other problems as well, especially with glaciation and river erosion and their effects on the present surface.

The third bulletin, by Mr. H. H. Barrows, besides dealing with the general physiography of the region concerned, will discuss several of the distinctive features of this valley, such as the striking narrowings and widenings, the terraces, which are one of the pronounced features of this valley; the alluvial fans, which have an unusual development considering the relief and climate of the region, and the influence of the geology on the industrial development of the region.

The fourth bulletin, by Professor N. M. Fenneman, will explain the general physiography of the region about St. Louis, which will furnish some important data concerning the date of excavation of the Mississippi valley—data which have some bearing on the crustal movements in late geological times; a discussion of river deposition, which is well illustrated by the main valley of the region; and discussions of a number of minor points which find illustrations in this region.

The fifth bulletin, by J. E. Carman, besides presenting a general sketch of the history of the present topography, will discuss the somewhat extensive deposits of sand and loess made by the wind; the origin of certain lacustrine or fluvio-lacustrine deposits in some of the tributary valleys; the effect of glaciation on the present surface, and the history of drainage changes. This last point is of much interest since the course of the Mississippi and of some other streams has been changed very notably, as the great valleys unoccupied or occupied by small streams show.

The next bulletin undertaken will probably deal with the Illinois valley between the mouth of the Desplaines and Hennepin.

In each of these regions there are factors of interest geographically, and in each there are important schools to be served. Each region, too, is relatively populous.

In some cases the work done in the preparation of these bulletins will probably lead to the development of information of importance, but in regions the geology of which is well understood they may do little more than put into available form the information which geologists already possess. Their value is not to be underestimated on this account, for the State which supports the survey has a right to information in such form that it may be available for the people.

It is the purpose of the survey to undertake the publication of similar bulletins about cities and villages in which are important educational institutions, as soon as practicable after topographic maps are available. The areas about State normal schools might appropriately receive early attention, but the areas about none of the normal schools have topographic maps at present, and without such maps the bulletins would fail of much of their purpose.

LEAD AND ZINC.

The ores of these metals are found in both the northern and southern parts of the State, and mining is now being carried on in Jo Daviess, Pope and Hardin counties. In the first named county the search for zinc has been particularly active in recent years. The director of the survey, before assuming his present position, made a general study of these mines for the U. S. Geological Survey* as well as a general study of the whole upper Mississippi valley zinc and lead region. Supplementary to this study detailed maps are needed throughout the productive area. A beginning has been made toward supplying this need. The work has been placed in charge of Dr. U. S. Grant of Northwestern University, Consulting Geologist of the Survey. Dr. Grant recently mapped the most productive areas in Wisconsin and it is planned to cover the Illinois field as it develops with maps similar in character.

This season the Vinegar Hill area, including nearly fifteen square miles, was surveyed on a scale of four inches to the mile by Dr. Grant and Mr. M. J. Perdue, assisted by Mr. E. M. Scheflow, levelman. A detailed topographic and geologic map was made and on it were placed structural contours from which the depth to the "oil rock" can be obtained at any point. As the "oil rock" and the beds immediately above it form the most productive horizon in the region, the map should be of great assistance in the development of the deposits. The map is now being engraved, and will be published as promptly as possible. It is proposed to extend these surveys to cover the whole of the productive area. As a preliminary step in this direction, the primary traverse and the primary level lines were this year run so as to permit of a topographic map being made of the Apple River and Galena quadrangles. This map will be upon the usual inch to the mile scale, and will supplement the large scale general maps.

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* Zinc and Lead Deposits of Northwestern Illinois; U. S. Geol. Surv. Bull. 246.

† Zinc and Lead Deposits of the Upper Mississippi Valley; U. S. Geol. Surv. Bull. 294 (In press.)

In southern Illinois very little zinc has so far been found, though the lead ore is steadily shipped as a by-product of fluorspar mining. When the topographic survey of the southern Illinois coal field has sufficiently advanced it is planned to take up the mapping of the fluorspar-lead district. The primary traverse and the level work is planned for 1907. In the meantime a general report upon the area, published by the U. S. Geological Survey*, is available. An interesting development of the year has been the finding of silver values in the lead ore sufficient to form an element in the purchase price. Of recent years the price of silver has been so low that the small amount of silver found in the galena was not paid for by the smelter.

FLUORSPAR.

The fluorspar deposits in Pope county are among the largest and most important in the world. In 1905 they yielded 33,275 tons of spar, having a value of $220,260. Some lead is found with the spar. Fluorspar is used mainly as a flux in steel making and in the enamelling trades, but also has a number of minor uses. As promptly as possible the geological mapping should be extended to cover the fluorspar districts and studies of the uses of spar should be made so as to widen the markets as much as possible.

QUARRY PRODUCTS.

Highway Materials.—In connection with the State Highway Commission, samples of rock and gravel now in use in the construction of roads have been collected at a number of points. These materials have been tested in the road material laboratory and reports have been duly forwarded to State Highway Engineer Johnson. The localities from which samples were collected are indicated on the accompanying sample map, and are listed below.

Gravel, Charleston, Ill.; collected by Savage. Test No. 24.

Crushed rock, Garrison's quarry, N. E. ¼ section 28, Casey township, Clark county; collected by Savage. Test No. 27.

Novaculite (flint) from Tamms, Alexander county; collected by DeWolf. Test No. 26.

Gravel, Bloomington, Ill., (near water works); collected by Hancock. Test No. 31.

Crushed rock, Utica, Ill., Sec. 8, T. 33 N., R. 11 E., Utica township; collected by Hancock. Test No. 36.

Crushed rock, Deer Park, near LaSalle, Sec. 33, T. 33 N., R. 1 E.; collected by Hancock. Test No. 37.

Crushed rock, one and one-half miles southwest of Ottawa, Sec. 15, T. 33 N., R. 3 E.; collected by Hancock. Test No. 39.

Crushed rock, Dixon, Ill., Sec. 33, T. 22 N., R. 9 E.; collected by Hancock. Test No. 40.

Crushed rock, Savanna, Ill., near C. B. & Q. R. R. tracks in north edge of town; collected by Hancock. Test No. 43.

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* Fluorspar Deposits of Southern Illinois, by H. Foster Bain; U. S. Geol. Surv. Bull. 255.

Crushed rock, Fulton, Ill., north edge of town, Sec. 28, T. 22 N., R. 11 E.; collected by Hancock. Test No. 44.

Crushed rock, Savanna, Ill., north edge of town, near C. B. & Q. tracks; collected by Hancock. Test No. 42.

Crushed rock, Mt. Carroll, southwest part of city; collected by Hancock. Test No. 46.

Crushed rock, Freeport, Ill., from city quarry; collected by Hancock. Test No. 41.

Galena limestone, southwest edge of Galena, in street; collected by Hancock. Test No. 45.

Crushed rock, Moline, Ill., The Cady Stone Quarry; collected by Hancock. Test No. 47.

Crushed rock, Moline, Ill., Cady Stone Quarry; collected by Hancock. Test No. 48.

Crushed rock, Moline, Ill., Cady Stone Quarry; collected by Hancock. Test No. 49.

Sandstone, Charleston, Ill., Oliver Quarry; collected by Bain. Test No. 23.

Crushed rock, Charleston, Ill.; collected by Bain. Test No. 25.

Limestone, Clark county, Stumps' Quarry, Wabash township; collected by Savage. Test No. 38.

No comprehensive study of highway material has been attempted. This is believed to be properly the work of the highway engineer, but it is proposed to utilize the survey corps as much as possible in the collection of samples and notes and outcrops. In this work Messrs. E. T. Hancock, F. W. DeWolf, T. E. Savage and F. B. Van Horn assisted in 1906.

Fertilizer Materials.—In certain portions of Illinois the soils, if a maximum crop is to be obtained, need treatment. Large quantities of limestone and phosphate of lime are annually imported and the amount which will be used seems likely to increase from year to year. Acting in coöperation with the Agricultural Experiment Station, a search has therefore been begun for local fertilizing materials. There is not much encouragement to hope for the finding of large bodies of phosphate rock, but in view of its importance to the State it has been thought that every effort should be made to locate such bodies. Accordingly samples of everything of possible value encountered in the course of the survey have been sent in and analyzed at the Experiment Station. The localities visited are indicated upon the accompanying map. So far nothing of any commercial importance has been found.

Limestone suitable for use upon certain soils in southeastern Illinois needing such material has been located and tested at a number of points, as is also shown on the accompanying map. The samples were collected by the Geological Survey and the analyses were made by the Agricultural Experiment Station. Mr. Van Horn has prepared a brief report upon the subject.

Building Stones.—The total stone output in 1905 amounted to over three and a half million dollars, divided as below:

Limestone—	
Crushed rock	$1,904;350 00
Flux	581,497 00
Limestone for highways	533,917 00
Stone for lime making	395,164 00
Dimension stone	226,491 00
Sandstone	29,153 00
Total	$3,670,572 00

The most important increase in demand has been for crushed rock. While our supply of stone for dimension work is relatively limited, good rock for crushing exists largely distributed. So far there has been no opportunity to make a special study of the building stones of the State, a subject which urgently demands investigation.

Cement Resources.—Portland cement is manufactured in the vicinity of La Salle and slag cement is made in the Chicago district. A new plant is being erected at Dixon and land is said to have been purchased near Port Byron for another. There are no cement factories in the central or southern part of the State. Since 1902 the cement industry of the State has been nearly stationary. In the meantime nine new plants have gone into operation in neighboring states, and a number of others are now building. The percentage of the output of the United States made from materials abundant in Illinois has jumped from 21.4 to 35.9, and the increased demand for cement has been enormous. Enough is known to indicate that there is an abundance of cement making materials, particularly in the southern part of the State. The large fuel supply available, the good transportation facilities enjoyed, and the fortunate geographic situation of Illinois entitle it to a greater share in the increased cement production. Analyses have been made of individual limestone and shales, but funds have been lacking for the thorough study of the whole subject which its importance demands.

Sand and Silica.—In the vicinity of Ottawa are deposits which furnish a large portion of the glass sand used in the United States. This sand, which belongs to the St. Peters sandstone, also enters into a number of other trades. The beds outcrop near Dixon to the north and again in Calhoun county. Other formations also yield sand suitable for making bottles, for building, molding and other purposes. In the aggregate the annual output amounts to about three-quarters of a million dollars. The deposits should be studied and tested in order to determine their extent and quality and with a view to finding new uses and markets for the material.

In southern Illinois, in Union and Alexander counties, there are beds of fine grained silica which are in demand in the wood polishing and other trades. Three mills are now engaged in preparing the silica for market, and others are projected. The origin and extent of these beds are very imperfectly known, and it is not likely that all the uses to which it is adapted have been discovered. Preliminary to a thorough study of the entire subject samples have been taken and analyses are being made. It is hoped to follow these by further tests and surveys.

Ochre.—Colored clays of such quality that they may be used as pigments occur at different points in the State. The bulk of the colored clays fail in some particular or another, and are not adapted to such uses. From time to time samples sent into the office or collected by members of the survey have been tested, usually with negative results. One sample from Brown county appeared promising, and on being examined by one of the largest paint manufacturers in this country found to be of value. The owner was put into communication with the paint makers and thus a market was found for his material. It is possible that other deposits exist, and it is hoped that they may be found and exploited.

General Stratigraphy.

A correct knowledge of the geology of the State as a whole is fundamental to any development of its mineral resources. The work on coal, clay, lead and zinc and other topics has, accordingly, been arranged to throw as much light as possible on the geology of the whole State. In order, however, to make the best progress, it has been found necessary to have some one whose major time should be devoted to this particular work. To Dr. Stuart Weller accordingly this duty has been assigned. He has visited each of the field parties, and has taken charge of the collections now being made. In addition, he has independently investigated certain areas adapted to throw light upon the general geology of the State. Some time was spent by him in southern Calhoun county. A brief report upon this area has been prepared and will be submitted for printing. Later Dr. Weller made a reconnaissance along the Mississippi river from St. Louis south. Early in the year he prepared a preliminary geological map of the State which was published in Bulletin 1 of the survey and has served a very useful purpose. He also furnished brief notes on the geological structure of the State for incorporation in the bulletin on petroleum and a revised copy of the geological map of the State for use in a second edition of Bulletin No. 1.

As a further preparation for detailed work, Mr. DeWolf was employed in May and June to make a general reconnaissance of southern Illinois, particularly of that portion in which Tertiary and Cretaceous strata outcrop. Mr. DeWolf is regularly employed by the U. S. Geological Survey and was detailed for this temporary service through the courtesy of the director of that organization. His trip brought to light many interesting facts regarding the area traversed, and will be of much assistance in future detailed surveys. An immediate return of the work is the report on the fire clays of that region appearing in the year book.

Arrangements have been made for collecting and recording the logs of deep wells as they are bored, and in this the active coöperation of municipalities, corporations and citizens is invited. In no other way than by the systematic collection and comparison of deep well records can the geology of much of the State be learned. A considerable number of records are now available, but many more are needed. A notable addition to the records is a diamond drill core from Delafield extending to a depth of 962 feet. This was courteously furnished to the survey by the Delafield Coal Company, and has been carefully examined by Mr. John A. Udden. If, when deep holes are to be put down, the survey is informed, it will furnish directions for the collection and preservation of samples, will examine the same, and will give such advice as to horizons as the circumstances permit. The preservaton of such records is of great importance to the future development of artesian waters, oil, gas, coal and often minerals of the deeper rocks.

MINERAL STATISTICS.

One of the most important aids to the economic development of an area is the publication of accurate statistics of production. In Illinois very full and satisfactory statistics of the coal production are published annually by the Bureau of Labor Statistics. These figures are for the fiscal year, and there is no local agency collecting figures by the calendar year. Since this is the year used by most industries, it is important to have figures also from January to January. No one within the State collects statistics of output of the clay, stone, sand, oil and other mineral products than coal. The U. S. Geological Survey has for a number of pears collected such statistics in Illinois as in other states, and arrangements have been made for coöperation with that organization in this work. Under this arrangement the correspondence is carried on as usual through the Washington office. The State Survey undertakes to assist in obtaining returns from delinquents and in revising and correcting the list of producers. Under this arrangement Mr. Van Horn spent some time in the work last winter, and prepared a separate circular giving the production in 1905. His totals are given below. If gas, silica, zinc and other minor materials were included the grand total would undoubtedly be considerably increased.

Total Value of Mineral Output in 1905.

Coal	$40,577,592 00
Clay	12,392,100 00
Limestone	3,644,499 00
Portland cement	1,741,150 00
Sand (estimated)	700,000 00
Natural and slag cement	166,550 00
Fluorspar	220,206 00
Petroleum	126,567 00
Lead ore	48,000 00
Mineral water	44,995 00
Sandstone	29,153 00
Total	$59,680,817 00

These figures include only the output of the mines and quarries of the State. If to them be added the output of smelters, which, however, work almost entirely on raw material from outside the State, the total would be raised to over $100,000,000.00.

Publications.

Three bulletins and one statistical circular have been printed and distributed. Manuscript for four additional bulletins are now in hand and being prepared for the printer. In addition, a number of reports are in a more or less advanced state of preparation. These are listed below.

REPORTS PRINTED.

Bulletin 1. The Geological Map of Illinois. By Stuart Weller. (24 pages and folded map.) The map, which is on the scale of two miles to the inch, shows the distribution of the different geological formations by colors and patterns. The shipping coal mines are also located, and vertical sections illustrate the character of the different rocks in different parts of the State. There is an accompanying brief explanatory text. The map is based upon Worthen's map of 1875, but includes such corrections as were available at the beginning of the present survey. It makes no pretensions to great accuracy in detail, but has proven useful as a guide to further investigations. The value of such a map depends upon the fact that it shows the distribution of the natural economic products which exist within the crust of the earth in any region and of the rocks in which similar deposits are likely to occur. As the survey progresses, more accurate maps may be made, and their value will steadily increase.

Bulletin 2. The Petroleum Industry of Southeastern Illinois. By W. S. Blatchley. With sections by Messrs. Weller, Grout and Savage. (109 pages.) In this report the nature and the uses of petroleum, its origin, mode of occurrence and production are discussed. The petroleum bearing rocks of Illinois are briefly noted and the known oil occurrences within the State are systematically discussed. This report has been in great demand among intending investors in the region.

Bulletin 3. Composition and Character of Illinois Coals. By S. W. Parr. With chapters on the distribution of the "Coal Beds of the State" by A. Bement, and on the "Tests of Illinois Coals under Steam Boilers" by L. P. Breckenridge. (86 pages.)

In this report Professor Parr presents the results of a large number of analyses of Illinois coals and discusses their bearing on the classification of coals. Mr. Bement gives a map showing the general distribution of the principal coal beds, and Professor Breckenridge presents a tabular summary of the results of boiler tests of Illinois coals. In addition the figures of coal production for 1905 are given, and a map is printed showing graphically the relative intensity of production in different parts of the State.

Circular 1. The Mineral Production of Illinois in 1905. By F. B. Van Horn. Statistics of production of coal, clay, stone, etc., summarized by counties and subject.

REPORTS READY FOR PRINTING.

Water Resources of the East St. Louis District. By Isaiah Bowman, assisted by Chester A. Reeds. A full discussion of the geologic, topographic and economic features of the water resources of this important district. Illustrations are being prepared.

Geographic Features of the Lake Michigan Shore North of Chicago. By W. W. Atwood and J. W. Goldtwaite. This will be the first of the educational bulletins, and is designed to put in form useful to the schools certain data regarding the present and the past history of the lake. Illustrations are being prepared.

Year Book for 1906. This includes a number of short papers dealing with various phases of the survey work, among which is a Preliminary Report on Certain Fire Clays, by R. C. Purdy and F. W. DeWolf; Limestones Available for Fertilizers, by F. B. Van Horn;

The Delafield Drill Core, by Jon A. Udden; Report on the work done in the St. Louis Area, by N. M. Fenneman, and Notes on the Geology of Southern Calhoun county, by Dr. Stuart Weller, and Water Resources of the Springfield Quadrangle, by T. E. Savage.

The Geological Map of Illinois. By Stuart Weller. This will be a revised edition of the map and text forming Bulletin 1, the edition of which is almost entirely exhausted. The map is now being engraved.

REPORTS IN PREPARATION.

Report on the Paving Brick Clays of Illinois. This, which will summarize the bulk of the work done on the clays since the organization of the survey, will include chapters on the Geology of Clays, by Professor C. W. Rolfe; the Construction and Care of Brick Pavements, by Professor Ira O. Baker; The Testing of Paving Brick Clays and the Manufacture of Pavers, by R. C. Purdy. Certain of these chapters have been finished and circulated separately in a preliminary edition. It is expected that the entire report will be ready for the printer early in 1907.

A number of other reports are in less advanced state of preparation. These include a report upon the water resources of the State by Messrs. Bartow and Udden; a Bibliography of Illinois Geology by Mr. Van Horn; a further report on the composition of coal by Professor Parr and his assistants, and numerous brief papers upon other phases of the work. Comprehensive reports on the various coal fields and on other areas are planned for, but cannot be prepared without much additional field work.

Bureau of Information.

One very important portion of the State Survey work is the answering of inquiries regarding the mineral resources of the State. These inquiries come from all classes and from all parts of the State as well as United States. Land owners, manufacturers, miners, mine operators, oil prospectors, lawyers, teachers, railway industrial agents and many others have availed themselves of the services of the survey in the last year.

The number of inquiries answered in the first twelve months of the survey's existence is tabulated below. They indicate sufficiently perhaps the wide range of inquiries both geographically and by subject.

Requests for Information.

	Coal.	Oil.	Gas.	Clay.	Lead and Zinc.	Cement	Stone.	Water.	Maps.	Miscellaneous.
From in the State......	97	231	77	24	12	5	12	14	130	130
From outside the State	77	108	138	13	2	......	4	1	88	90
Total................	174	339	205	37	14	5	16	15	218	220

While many of the inquiries require only simple answers, others entail considerable work and lengthy correspondence. The survey is glad at all times to answer such inquiries so far as data available will permit. Arrangements have been perfected for the free examinations of specimens and materials so far as this does not involve extended laboratory investigations. No attempt has been made to furnish miscellaneous free assays or analyses, since the burden would rapidly become disporportionate to the benefits to the State and a single individual or firm could easily keep the whole force busy to the exclusion of any comprehensive investigations. There are, however, many inquiries which can be answered without such assay, and this is believed to be a proper and profitable task for the survey corps.

Expenditures.

The annual appropriation for the Geological Survey amounts to $25,000.00. Of this sum $10,000.00 is allotted to coöperative topographic surveys and the remainder is devoted to geology. Below is given a tabular showing of the expenditures of the survey under the latter head. The expenditures for topography are reported separately.

Statement of expenditures of the State Geological Survey during the years 1905-1906 and 1906-1907, exclusive of topography.

Appropriation 1905–1906		$15,000 00
Expended for work on—		
Administration	$1,602 81	
Office expenses	1,042 80	
Coal investigations	2,698 97	
Clay investigations	1,979 91	
Educational bulletins	327 65	
Water investigations	851 07	
Oil investigations	1,002 13	
Office furniture	2,207 23	
Mineral statistics	435 44	
Engraving map	906 00	
Paper and illustrations	644 74	
Revision of map	76 59	
Stratigraphy	119 15	
Miscellaneous	275 78	
		14,170 27
Balance on hand July 1, 1906		$829 73
Appropriation 1906–1907		$15,000 00
Expended for work on—		
Administration	337 41	
Office expenses	592 39	
Coal investigations	1,298 65	
Clay investigations	1,707 93	
Educational bulletins	271 18	
Water investigations	156 28	
East St. Louis surveys	428 34	
Springfield surveys	488 21	
Peoria surveys	496 83	
General stratigraphy	851 55	
Reports	144 60	
Lead and zinc surveys	315 53	
Miscellaneous	58 20	
		7,147 10
Balance on hand November 1, 1906		$7,852 90

It will be noted that in the first four months of the present fiscal year half the funds for the year were expended. This is due to the fact that the heaviest expense falls in the summer months when the largest force is at work in the field.

The expenditures for engraving and for other purposes connected with the reports were not originally allotted, for since section 6 of the Act establishing the survey provided that the printing of the reports should form a part of the State printing contract. Owing to the wording of the law the Attorney General held that this did not cover the items here noted, and so, pending an amendment of the section, the payments have been made from the general funds of the survey.

Topographic Surveys.

ORGANIZATION.

As contemplated by the law under which the Geological Survey was organized, the topographic work is being carried on in coöperation with the U. S. Geological Survey. The following reports give very briefly the results up to date. A more detailed report has been prepared for publication in the year book. The accompanying plate illustrates even better than the report, the excellent progress which has been made. Necessarily a considerable portion of the funds available has been spent in running lines of level and precise control in advance of the present surveys and in preparation for the work of succeeding years. It is planned for the present to confine the surveys mainly to the coal fields, since it is felt it is there that such work will be of most immediate and practical value. It is there also that topographic surveys are most needed for geological work. It should not be inferred that exactly the same sort of a map will necessarily be made throughout the State. In certain areas maps of larger scale and with more detail will doubtless be called for, and in fact one such may already has been made in the lead and zinc region. In other portions of the State probably a less complete and therefore less expensive map will serve present purposes.

COÖPERATIVE TOPOGRAPHIC REPORT, ILLINOIS, 1905-6.

WASHINGTON, D. C., Dec. 28, 1905.

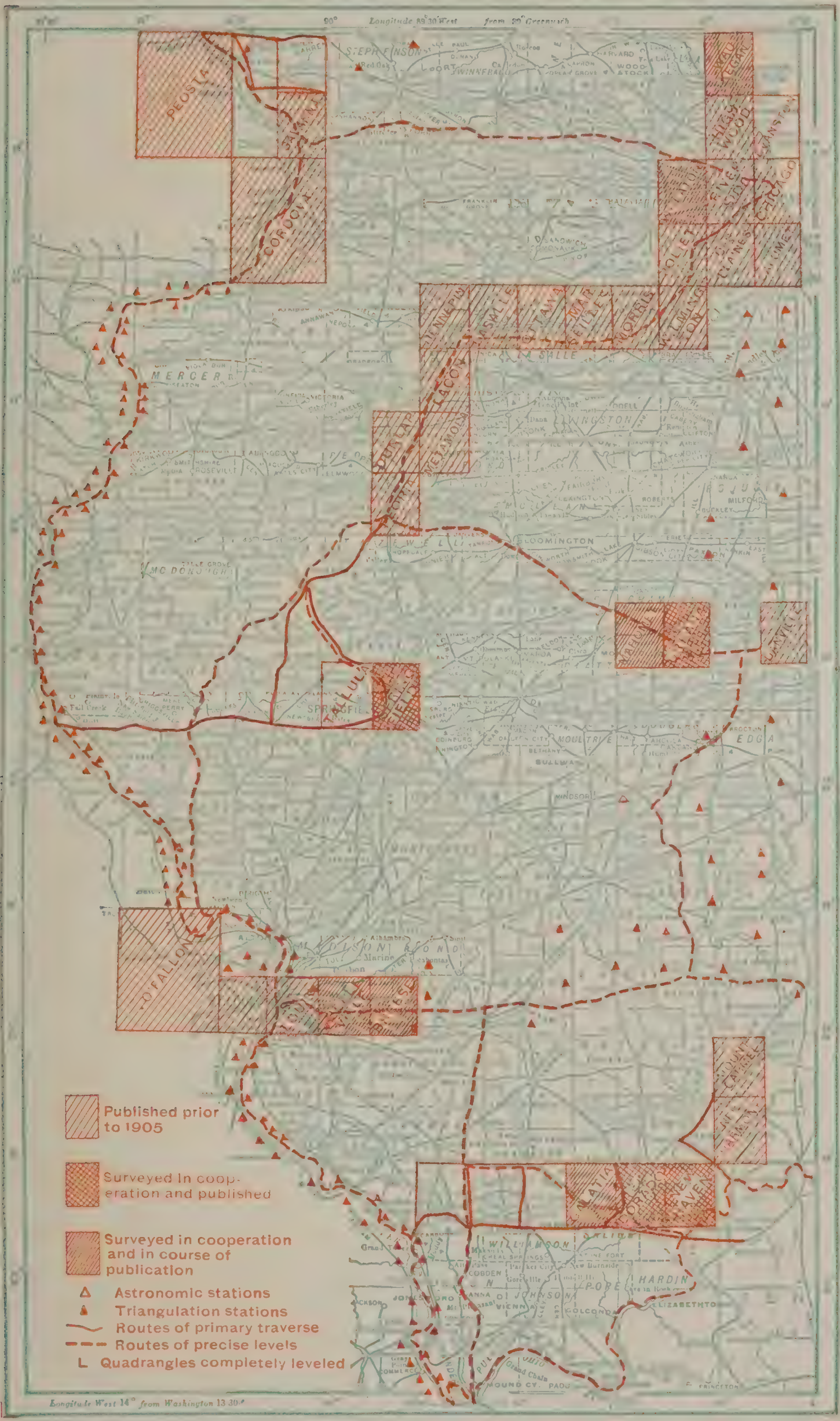
His Excellency, The Governor of Illinois, Springfield, Illinois:

SIR—I have the honor to make the following preliminary report of the coöperative topographic survey of the State of Illinois for the year 1905-6:

ALLOTMENTS.

In Senate amendments of May, 1905, to House Bill No. 63, of the Forty-fourth General Assembly of the State of Illinois, the commissioners of the State Geological Survey were authorized to arrange with the director or other repesentative of the United States Geological Suvey for a coöperative topographic survey of the State of Illinois.

In an agreement signed by you on Nov. 17, 1905, on behalf of the State, and by me on Nov. 20, 1905, on behalf of the federal gov-



Map showing progress of co-operative topographic surveys.

ernment, formally confirming our preliminary verbal agreement of May, provision was made for the execution of this work. In this it was provided that the total cost to the State of Illinois should not be more than $10,000.00 from July 1, 1905, to June 30, 1906, and that the United States Geological Survey should expend an equal amount upon the same work for the same period of time. On behalf of this survey I allotted an equal amount.

In correspondence of May, 1905, between President James of the University of Illinois, and Mr. H. M. Wilson, geographer, of this survey, supplemented by additional recommendations by yourself, plans have been made for surveys within the State and such plans have been carried to completion.

From the expenditure of the funds providing for this coöperation a complete and accurate may has been made for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet, of 1347 square miles of the area of the State, which is represented on the following six sheets; namely, Belleville, in Madison and St. Clair counties; Eldorado, in Gallatin, Hamilton, Saline and White counties; Mahomet, in Champaign and Piatt counties; New Haven (Ill., Ind., Ky.), in Gallatin and White counties; Springfield, in Logan, Menard and Sangamon counties; Urbana, in Champaign county. In addition 83 square miles were mapped over the edges of these sheets, which will be incorporated in future may work.

Considerable preliminary work was accomplished on the following quadrangles: Breese, in Bond, Clinton, St. Clair and Madison counties; Carmi (Ill., Ind.), in White county; Havana, in Fulton and Mason counties; Petersburg, in Logan, Menard and Sangamon counties; Saidora, in Cass, Fulton, Mason and Schuyler counties; Wheaton, in DuPage county. Of these the Breese and Wheaton quadrangles were about half surveyed.

During the season there were run on all of the above 11 sheets 3,740 miles of spirit levels, in the course of which 24,446 elevations and 101 permanent bench marks were established; there were run 6,221 linear miles of road traverse, every bend and every house being accurately located.

Two parties extended primary traverse over the counties of Champaign, Clinton, DuPage, Madison, Menard, St. Clair, and Sangamon, resulting in the occupation of 1,411 stations and the running of 401 miles of traverse. One party extended precise levels over the counties of Champaign, DeWitt, McLean, Piatt and Tazewell, resulting in the running of 87 miles, in the course of which 20 elevations and 33 permanent bench marks were established.

I feel gratified in being able to report such excellent results in view of the late date at which the coöperation was perfected. and the consequenct shortness of the season. It offers assurance that even better progress may be looked for another season, when parties may be placed in the field at an earlier date and with a perfected organization.

Very respectfully,
(Signed) Chas. D. Walcott,
Director.

Coöperative Topographic Report, Illinois, 1906-7.

Washington, D. C., Dec. 15, 1906.

His Excellency, The Governor of Illinois, Springfield, Illinois:

Sir—I have the honor to make the following preliminary report of the coöperative topographic survey of the State of Illinois for the year 1906-7:

ALLOTMENTS.

At the beginning of the field season of 1906 there was a deficit from coöperation of the previous year of $778.70, from the allotment of the U. S. Government. In other words, it had overspent by this amount its allotment of $10,000.00. The State of Illinois balance was $513.34, and the new appropriation beginning July 1, 1906, $10,000.00. The gross sum available therefore to surveys from that date was $19,734.64.

RESULTS.

Correspondence was immediately entered into between the director of the State Geological Survey, Dr. H. Foster Bain, and Mr. H. M. Wilson, geographer, of this survey, in which plans were perfected for the work to be executed during the year, and such plans have been carried to completion.

From the expenditure of the funds providing for this coöperation, a complete and accurate map has been made for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet, of a land area of 884 square miles of the State, which is represented on the following four sheets, namely: Breese, in Bond, Clinton, Madison, and St. Clair counties; Galatia, in Franklin, Hamilton, Saline, and Williamson counties; Waukegan (Ill., Wis.), in Lake county; Wheaton, in Cook and DuPage counties. Tallula, in Cass, Menard, Morgan and Sangamon counties, was completed with the exception of 13 square miles, and this will be completed in the early spring with the balance of funds available. There were mapped on this sheet during the present season 211 square miles, 5 square miles having been mapped in 1905. In addition, on all of the above sheets there were mapped 90 square miles over the edges, which will be incorporated in future map work. Considerable preliminary work was accomplished on the following quadrangles, namely: Galena (Ill., Ia.), in JoDaviess county; Thompsonville, in Franklin and Williamson counties; Herrin, in Franklin, Jackson, Perry and Williamson counties.

During the season there were run on all of the above sheets 4,518 miles of spirit levels; also 15,336 elevations, with 66 permanent bench marks established. There were run 3,227 miles of road traverse, upon which every bend and every house was accurately located.

One party extended primary traverse over portions of the counties of Franklin, Hamilton, Jackson, JoDaviess, Perry, Lake, Saline and Williamson. Office computations which will result from the work will furnish the geodetic positions of a great many points to which to tie future topographic and property surveys. This work resulted in the occupation of 1,671 stations, and the running of 398 miles of traverse. One party extended precise levels over portions of the counties of Cole, Cumberland, Douglas, Edgar, Franklin, Gallatin, Jasper, Richland, Saline and Vermilion. This work resulted in the running of 206 miles of double-line precise leveling, in the course of which 485 elevations and 76 permanent bench marks were established. These furnish exact heights through which to refer to mean sea level any spirit leveling which may be done hereafter by private or public organizations.

Owing to the late date at which it was possible to resume field work, namely, after the first week in July, because neither State nor federal funds were available until the first of that month, the field season was unusually short. In spite of this I am glad to be able to report as good progress as could have been anticipated. Three of the atlas sheets mapped during the previous year, Urbana, New Haven and Eldorado, have been engraved by this survey at no expense to the State, and copies of these publications are sold at the nominal price of five cents per copy.

Very respectfully,

CHAS. D. WALCOTT,

Director.

EXPENDITURES.

For 1905 there was available $10,000 each of State and federal funds. Of this all of the State funds except a balance of $513.34 had been expended to the close of the year ending July 30, 1906. All of the federal funds had been expended and in addition an overdraft of federal funds for the succeeding year was made to the extent of $778.70.

At the beginning of the second year of coöperation, July 1, 1906, there was available $10,000.00 each of State and federal funds, and taken in conjunction with the balance and overdraft above enumerated, there remained an available fund amounting to $19,734.64. Of the funds for this year all of the State appropriation has been exhausted excepting a balance of $3.04. This, because under the terms of the agreement the State funds are to be used chiefly in meeting miscellaneous field expenditures. Of federal funds there remained Dec. 1, a balance of $3,120.16. This balance has been reserved in accordance with the agreement in order to meet the permanent salaries of civil service employés, who will be engaged in office throughout the winter in completing the drafting of the topographic maps. It is estimated that these salaries will amount to $2,800 and that about $200 additional will be needed to meet back bills coming due for transportation, expressage, etc., and any balance, possibly $100.00, which may remain in the early part of the field season will be devoted to completing the few square miles unmapped upon the Tallula quadrangle.

RESUME OF RESULTS, 1905, 1906.

During the field seasons of 1905 and 1906 there were mapped 2,492 square miles, at a total expenditure for field and office work of $39,735.00. Including the cost of primary triangulation and precise levels and uncompleted mapping, this is at the rate of nearly $16.00 per square mile. This control includes a large amount of preliminary work toward future topographic surveying, there remaining about

1,200 square miles controlled by primary triangulation and precise leveling through which to reduce future spirit leveling to mean sea level.

Topographic surveying will have been completed on 11 sheets during the two years of coöperation. The following tabular statement gives the names of these sheets, their areas within the State, scale, contour interval and year mapped:

TOPOGRAPHIC ATLAS SHEETS MAPPED IN COÖPERATION.

QUADRANGLE.	AREA MAPPED.	YEAR.		CONT. INT.	Scale.
	Sq. Miles.	Original survey.	Resurvey or revison.	Ft.	
Belleville	233.28	1905	....	20	1.62500
Breese	233.28	1906	....	20	1.62500
Eldorado	235.66	1905	....	20	1.62500
Galatia	235.66	1906	....	20	1.62500
Mahomet	228.40	1905	....	20	1.62500
New Haven, (Ill., Ind., Ky.)	192.78	1905	....	20	1.62500
Springfield	229.22	1905	....	10	1.62500
Urbana	228.40	1905	....	10	1.62500
Waukegan, (Ill., Wis.)	149.00	1806	....	10	1.62500
Wheaton	225.50	1906	....	10	1.62500
In process of mapping:					
Tallula	211.00	....	....	....	....
Total	*2402.18	....	....	....	....

* In addition 90 square miles were mapped over the edges of quadrangles in 1906.

Recommendations.

In view of the needs of the work of the survey and the demands made upon it the following recommendations are made:

1. That the present annual appropriation for the general support of the survey, including topographic work, be raised from $25,000.00 to $30,000.00 per year. This is for the purpose of permitting investigations of cement materials, building stones, sands and other quarry products for which there have been no funds available so far.

2. That the defects in section 6 of the present law be corrected so as to carry out the intent regarding the printing of the reports.

3. That a special appropriation of $10,000.00 a year for two years be made for the investigation of coal mining and accidents in coal mines, particularly those due to explosions. It is believed that the large loss of life and property annually resulting from explosions fully warrants a comprehensive investigation of their cause so that proper precautionary measures may be adopted. This should also cover such investigations as may be possible of waste in coal mining and the means of reducing it.

4. That a special appropriation of $10,000.00 a year for two years be made for the survey and investigation of swamp and overflow lands in the State, and the measures necessary to their reclamation. Despite the efforts of local drainage boards there remains considerable unreclaimed land which is capable of becoming as productive as any in the State. Destructive floods in a single year wipe out property worth more than the whole cost of proper works to control certain rivers. Any works constructed to remedy these defects should be built according to plans taking into account the whole valley and the flood action of the whole river. Before such works are attempted, whether by State or local boards, the subject should be thoroughly investigated and the area of lands to be so benefited determined by accurate surveys at the same time that the proper methods of river control and costs are studied.

1908
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STATE GEOLOGICAL SURVEY.

Governor C. S. Deneen, T. C. Chamberlin, E. J. James, Commissioners
H. Foster Bain, Director,

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Administrative Report for 1908

BY

H. FOSTER BAIN

URBANA
University of Illinois.
1909

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STATE GEOLOGICAL SURVEY.

Governor C. S. Deneen, T. C. Chamberlin, E. J. James, Commissioners;
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1909.

ADMINISTRATIVE REPORT FOR 1908.

(BY H. FOSTER BAIN, DIRECTOR.)

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LETTER OF TRANSMIITTAL.

State Geological Survey.
University of Illinois, Feb. 15, 1909.

Hon. C. S. Deneen, Chairman, and Members of the Geological Commission:

Gentlemen—I submit herewith my administrative report covering the work of the State Geological Survey for the year 1908, with recommendations for the ensuing year. I suggest that a preliminary edition of fifteen hundred (1,500) copies be printed promptly for the use of the General Assembly and that an abstract of the report be issued in the Year Book for 1908.

Very respectfully,
H. Foster Bain,
Director.

ADMINISTRATIVE REPORT.

INTRODUCTION.

General.—Illinois ranks third in mineral production. Complete figures for 1908 are not available but probably the total will not differ greatly from that for 1907 when the value of the mineral output amounted to $152,221,284.00. Omitting pig iron, produced in Illinois but made mainly from imported materials, and a part of the zinc production for the same reason, the output was $93,415,404.00. This total, large as it is, is small in comparison with our possibilities. For example since 1902 the Portland cement output of the State has remained nearly stationary despite the increasing use of such cement and the presence of abundant material within the State. In the meantime many new plants have been built in neighboring and competing states. In many lines of clay goods we import rather than manufacture. Silica and certain other materials, occur abundantly in the State but are so little known or so little appreciated as to have been very slightly used.

To assist in the economical development of these and all our other mineral resources, the State Geological Survey was created. Its functions are broad and it has a part in the solution of all public problems into which a knowledge of geology enters. The finding of limestone suitable for use on acid soils, the regulation of our rivers and the reclamation of undrained lands, the location of materials for use on the public highways, the bettering of conditions in our coal mines, the finding of adequate public water supplies, the better direction of exploration for gas, oil, and other buried resources of our commonwealth; with all these problems the State Survey, either alone or in coöperation with other State bureaus, is concerned. Its work is educational—the collection and dissemination of as accurate knowledge as possible regarding our mineral resources and our geological environment—of the great natural platform on which our civilization and our industries depend. Its methods involve field studies, laboratory tests, library research, and comparison with other areas and with industrial development in other states. The investigation is necessarily continuous since conditions change and new knowledge renders necessary and valuable a re-interpretation of old observations. The present State Geological Survey was organized in 1905, no appropriation having previously been made since 1875. There was in a sense thirty years of back work to do, since during all that time drill holes had been put down and changes had taken place which needed to be made a matter of record and study if they were to be used. A new organization was to be created and methods adapted to this particular field needed to be developed. Much of this has now been done. The various steps so far taken are detailed in this and the preceding administrative reports.

The work is now organized and the methods determined. The rate of progress will be measured largely by the funds available and with much of the work the sooner it is done, the sooner the people of the State will get the benefit. The work is of cumulative value. One topographic map has an important but still local value; a complete set of maps of a river valley permits the economical and wise planning of the regulation of the river for power, navigation, land reclamation and water conservation. A single map in an oil field is of some value; but complete maps of the field, or better still, structural maps of the whole area, permit very accurate determination of the areas favorable for prospecting. A single sample and analysis of coal means little; but a complete set of analyses and samples for a field or a State may mean the entry of the coal into a wholly new market. It is important therefore to keep steadily at the work and to do it on as generous a scale as the revenues of the State will warrant. That the work now being done answers a real need is shown by the hundreds of requests for specific information which come to the survey office and the thousands of requests for reports. Indeed the demand for reports is so great that it has been necessary to increase the number printed and also to print in one case a second edition. It will probably be necessary to print repeated editions of several of the bulletins.

Organization and Personnel.—The organization of the Geological Survey in 1908 remained substantially the same as in 1907. Three sections were recognized: (a) geologic; (b) topographic; (c) drainage. The first was administered by the director, aided by Assistant State Geologist DeWolf. The second was in charge of W. H. Herron, geographer in charge of the central section for the U. S. Geological Survey. The third was directed by Mr. Herron assisted by E. W. McCrary, engineer.

Within the year comparatively few changes occurred in the personnel. On July 1st R. S. Blatchley joined the corps and was assigned to the duty of making a detailed study of the Robinson oil field. At the close of the field season he assumed in addition the duties of chief clerk. Miss Opal Lockwood began work as clerk on July 1st and G. M. Wood left the survey to take up private work in November. In addition to the regular corps as given below Messrs. F. E. Layman, C. F. Knirck, A. J. Ellis, W. E. Deuchler and a number of others served for short periods of time in the field or office. The general organization, exclusive of certain temporary employés was as given below:

COMMISSIONERS.

Governor C. S. Deneen, Chairman.
Professor T. C. Chamberlin, Vice Chairman.
President E. J. James, Secretary.

ADMINISTRATIVE WORK.

H. F. Bain, Director.
R. S. Blatchley, Acting Chief Clerk.
Samuel Abrams, Clerk.

GEOLOGICAL SECTION.

F. W. DeWolf, Assistant State Geologist.
R. D. Salisbury, Consulting Geologist.
U. S. Grant, Consulting Geologist.
C. W. Rolfe, Consulting Geologist.
S. W. Parr, Consulting Chemist.
Edward Bartow, Consulting Chemist.
Stuart Weller, Geologist.
T. E. Savage, Geologist.
J. A. Udden, Geologist.
A. V. Bleininger, Ceramist.
E. F. Lines, Assistant Geologist.
R. S. Blatchley, Assistant Geologist.
Jon. Udden, Field Assistant.
G. H. Cady, Field Assistant.
J. C. Jones, Field Assistant.
Opal Lockwood, Clerk.

TOPOGRAPHIC SECTION.

W. H. Herron, Geographer.
W. J. Lloyd, Topographer.
M. Hackett, Topographer.
E. W. McCrary, Assistant Topographer.
A. T. Fowler, Assistant Topographer.
C. B. Kendall, Assistant Topographer.
W. A. Gelbach, Junior Topographer.
G. L. Gross, Junior Topographer.
Lee Morrison, Junior Topographer.

DRAINAGE SECTION.

W. H. Herron, Geographer.
E. W. McCrary, Engineer, in charge of Kaskaskia River Surveys.
W. J. Lloyd, Topographer, in charge of the Big Muddy River Surveys.
P. E. Fletcher, Engineer, in charge of Primary Levels.
G. M. Wood, Clerk.

Coöperation.—As in previous years the State Geological Survey has worked in close coöperation with a number of other organizations. With the U. S. Geological Survey there has been formal coöperation in the topographic work, the study of the coal fields, and the collection of mineral statistics, and informal coöperation in the drainage work and the study of clays, of cement materials, and of water resources. The special work of the State Committee on Water-Ways Reclamation has continued with the active coöperation of the Internal Improvement Commission and the U. S. Department of Agriculture. The chemical studies of coal have been carried on as heretofore in connection with the Engineering Experiment Station, the Graduate School and the Department of Applied Chemistry of the University of Illinois. The arrangement covering exchange of information with the State Water Survey has continued. Augustana College has furnished office facilities for J. A. Udden in his work of collecting and studying drill records and the University of Chicago for the men writing educational bulletins. In the State Conservation Commission, organized by the Governor in December, the State Survey is represented by the director. It is expected that through this commission an even better coördination of the State work and closer coöperation with the various State bureaus will be brought about.

Acknowledgment should be made to the numerous firms and individuals who have supplied the survey with drill records and other notes often of a confidential character. The response to our requests for such information has been everywhere instant and hearty and the records now being collected and correlated will be of the highest value in the difficult task of working out the stratigraphy of the deeply buried portions of our great coal and oil fields.

GEOLOGICAL SECTION.

The administration of the geological section of the survey has been in the hands of the director and of Assistant State Geologist DeWolf. The principal work of the year has been directed toward:

(a) The collection and compilation of drill records with a view to the making of a preliminary structural map of the State.

(b) The study of the coal fields of the State as a whole with a view to the preparation of a general report in advance of the detailed mapping.

(c) The completion of the investigation of the Portland cement materials of the State, including the sampling and testing of the clays and shales.

In addition the usual work of the bureau of information, that of collecting mineral statistics, and the studies of stratigraphy and of mineral resources were carried on. The details are given in following pages.

General Stratigraphy—The principal work of the year has been in connection with the collection and study of deep drill records. In a State such as Illinois, in which outcrops are relatively rare and over which there is quite generally a thick drift cover, the careful preservation and study of deep drill records is especially important. Only by this means will the geology of much of the State ever be learned. Deep holes are usually drilled in this area in search of water, coal, or gas and oil. The methods of drilling for these differ materially. Expert drillers for one may be quite inexpert when looking for the other. The men in one industry are seldom in touch with those in either of the others. On this account the work has been organized in three sections: F. W. DeWolf being in charge of the collection and study of coal test drillings, R. S. Blatchley looking after oil and gas well records and J. A. Udden collecting and examining drillings from wells put down in search for water. In each case the general purpose has been to collect and correlate the records of as many deep borings as possible. This is being done both by correspondence and personal visit. Each boring is located as accurately as possible and its elevation above sea level determined by reference to railway grade or to actual surveys where necessary. For convenience in reference a map has been prepared with a tack bearing a key number in each township for which records are available. At present there are nearly 5,000 records in our files. These are fairly well scattered over the State though there are considerable areas in which we have none. In others the records are incomplete and inaccurate and it will be necessary to secure better ones. This, and the study of those at present available, is the work now being undertaken. The details are given under the separate subjects.

The study of these records can not prove of great value except in connection with corresponding studies of the outcrops of the rocks. The general work on the stratigraphy of the State is therefore being pushed forward rapidly, Stuart Weller of the University of Chicago remaining in general charge of this phase of work. He has devoted his personal attention to the Mississippian rocks, being assisted by Jon Udden. The Mississippian system is one of the most important in the State. In its upper portion are found some of our most productive oil sands. In lower beds are limestones and shales suitable for making Portland cement, stone for making lime, for building, for road metal, for use on soils, and for other purposes. In the same rocks are found the fluorspar, lead and zinc deposits of Pope and Hardin counties and certain minor occurrences of zinc not as yet found to be of commercial importance in the western part of the State. The Mississippian rocks, over much of the State form the base upon which our Coal Measures rest and from both the scientific and practical points of view they constitute one of the most important formations in the State. It is of first importance that their stratigraphy be understood and Dr. Weller is therefore devoting his main attention to them with a view to the preparation of a general report upon the subject.

The rocks below the Mississippian including the Devonian, Silurian and Ordovician, outcrop over considerable areas in Southern Illinois and are capable of yielding large amounts of stone of various kinds. In them also occur the silica deposits which are becoming more and more important. The stratigraphy of these rocks has been in some confusion and T. E. Savage has been assigned to work them up. He has spent parts of two field seasons in the area and has done his laboratory work under the direction of Professor Schuchert at Yale University. Important results have already been reached and a full report on the subject is in preparation. In the northern portion of the State the first steps have been taken toward a much needed re-study of the Niagara rocks. A. J. Ellis, acting under Messrs. Savage and Weller, has undertaken the collection of notes and specimens along the Niagara-Ordovician contact with very interesting results.

The general study of the Coal Measures has been carried out in connection with Mr. DeWolf's studies of the coal. The principal stratigraphic work has been done by David White, kindly detailed to that work by the U. S. Geological Survey. Upon the basis of correlations made by him, Mr. DeWolf and the various members of the State Survey working in the coal fields are preparing a wholly new map of the coal fields. Messrs. White and DeWolf spent some time in a general reconnaissance through the western part of the State studying the relations of the Coal Measures to the Pottsville and lower rocks. This trip was followed by one through the southern counties by Messrs. White, DeWolf and Bain, for similar work. At the close of the work in Illinois, Mr.

White spent some weeks in similar studies in Indiana, very greatly to the advantage of the work in our own State and it now seems probable that a satisfactory correlation of coal beds and a uniform nomenclature for the whole Eastern Interior Coal Field will be developed.

In the extreme southern part of the State is a limited area covered by rocks of the Cretaceous and Tertiary age. In 1906 a reconnaissance of this area was made by Mr. DeWolf but since then it has been impossible to spare any one for further work on these rocks. Fortunately the Federal Survey is engaged in a general study of the rocks of the Mississippi embayment and will be able shortly to send some one into this area. There are important fire clays, shales, and road materials to be derived from them and better knowledge of their stratigraphy is much needed.

Above the hard rocks over most of the State is a variable thickness of sand, gravel, and boulder clay resulting from the action of great ice sheets which in Pleistocene times covered so much of the State. Despite the great scientific and practical interest of these beds the survey has been unable to spare any one to take up their systematic study. During the season just passed, J. C. Jones, acting under the supervision of R. D. Salisbury, made a study of the Pleistocene deposits of the New Haven-Galatia area. W. C. Alden, for the U. S. Geological Survey, spent a short time in the study of the older drift sheets of northwestern Illinois. In the studies for educational bulletins, the glacial deposits of several areas have been studied, but there is room and need for a thorough general study of these deposits. In the Pleistocene are found the water supplies of most of our villages and towns; the gravels needed for road construction and for railway ballast; the sands for concrete and other building construction; clays for brick, drain tile etc.; important local sources of natural gas; and the distribution of the deposits controls, primarily, the character of our soils. Fortunately a general study of these deposits is available having been made some years since for the U. S. Geological Survey by Frank Leverett.[1] Much new data is however now available and many gaps remain to be filled. A map showing the distribution and character of the gravel beds of the State may be mentioned as one of the pressing needs which might be met by a study of these deposits.

Coal.—Illinois ranks second among the states in the production of coal. In 1907, 51,317,146 tons, having a total value of $54,687,382.00, were mined. The figures for 1908 are not complete but preliminary estimates indicate that Illinois was almost alone among the states in holding its production. While in the country as a whole the amount mined fell off from 15 to 20 per cent, Illinois mines produced as much as or possibly a little more than, in 1907, a record year. Despite this gratifying fact it remains true that our mines are not working to anything like their capacity. In 1907 the average number of days worked was 218. It would probably be fair to assume 300 working days a year as possible. On this basis there was a loss of thirty per cent of the possible working time and this is not an unusual per cent of loss in our State.

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[1] The Illinois Glacial Lobe, Mon. 38, U. S. Geological Survey.

The reasons for this are complex. In part they lie in the nature of the coal which prevents its storage without spontaneous combustion; in part, in the general ignorance as to correct methods of firing and the real value of the coal; and finally in part, in the present organization of the industry with excessive competition in selling. The net results are bad for the industry and therefore for the State as a whole. Cheap coal reduces manufacturing costs but allows wasteful burning. It also entails wasteful mining and even prevents the introduction of methods of safeguarding the men in the mines. It is a serious question whether we are not paying, in loss of life in the mines, in loss of efficiency in our plants, and in loss of interest and capital invested in the industry, more than the cheapness of the coal is worth.

A better understanding of what our coal resources are and the best methods of utilizing them will contribute largely to the solution of the various problems of the coal industry. To that end the work of the survey has been organized so as to cover both field and laboratory investigations. They have continued to be under the immediate supervision of Assistant State Geologist DeWolf. The field investigations are for the purpose of acquiring exact information regarding the distribution of our coal beds, their number, thickness, character of floor and roof, the dip, any faulting which may be present and, in brief, all data necessary to an exact inventory of the workable coal of the State and the natural conditions which influence the methods of working. This work is being carried on in coöperation with the U. S. Geological Survey which bears half the expense. The method is to make exact maps locating all natural outcrops or available drill holes, to determine their elevations, and to correlate the various coal beds with a view to making structural contour maps such as already have been presented in the year books of the survey. In final publication these maps are to be accompanied by reports discussing in detail the mineral resources of the areas. This final publication is to be made by the Federal government which assumes all the expense of the necessary printing and engraving.

The work so far completed includes reports on the Peoria quadrangle by J. A. Udden, of the Springfield quadrangle by T. E. Savage, on the Belleville-Breese quadrangles by J. A. Udden and on the New Haven, Eldorado and Galatia quadrangles by F. W. DeWolf. The survey of the West Frankfort quadrangle by Messrs. DeWolf and Cady is complete and a report is being prepared. The Herrin quadrangle was surveyed in the season just closed by T. E. Savage but a report will probably not be prepared for some months. A strip six miles wide extending from south of Marion to south of Harrisburg, and covering a portion of the area of coals No. 5 and No. 6 was surveyed this season by W. E. Deuchler under direction of G. H. Cady and the report is in preparation. Level lines were run to all known drill holes, and, while this area is outside the region topographically surveyed, it is believed that it can be satisfactorily mapped on this basis. It is proposed to extend similar surveys over the entire coal fields as rapidly as funds will permit and to execute them in such detail as the data available will allow. Something over 700 drill records have been collected and the holes located and leveled to, in the course of these detailed surveys.

Aside from the surveys mentioned, and in advance of the topographic mapping, Messrs. DeWolf and Jon Udden have been engaged in a study of the coal fields as a whole and the collection and correlation of drill and shaft records. These, in connection with the work of David White on the correlation of the coal beds will afford the basis for a general report upon the coal fields as a whole. In this connection Mr. DeWolf has made a special study of the Danville district and its relations to the Indiana coal fields and Mr. Udden, a careful study of the structural features of the Duquoin area. Practically all the coal producing counties of the State have been visited.

The field work included the careful sampling of all coal beds examined. There are now available satisfactory face samples of the coal in 148 mines, representing probably all seams worked. Less satisfactory samples of 129 mines are also available. Of this earlier series forty-one have been checked by later work and are included in the first figure given. The others are being checked as rapidly as possible.

The laboratory work on coal is directed toward the determination of its composition and heating value both in the mine and as actually marketed, and the solution of various chemical problems bearing on its better marketing and utilization. This work is being done is coöperation with the Department of Applied Chemistry of the University and the Engineering Experiment Station. It is under the direction of Professor S. W. Parr who in 1908 was assisted by W. F. Wheeler, J. M. Lindgren and for part of the year by C. K. Francis and Perry Barker.

A large volume of analytical work has been carried on within the year. Preliminary reports on part of this work have been published.[1] During the year 1908 face samples from approximately one hundred different mines were analyzed by Messrs. Wheeler and Lindgren. In addition a great many duplicates were taken for checking purposes and seventy samples of the collection of 1906 were analyzed for ash and moisture. Studies of field and laboratory methods were also carried on. These included comparison of samples from different parts of the same mine, comparison of samples obtained by quartering and in the laboratory, studies of moisture absorption by samples ground respectively by ball mill, discs and bucking board. A study was also made of accuracy of moisture determinations when based on coals of various sizes. These results will be published in a report by the Engineering Experiment Station.

Weathering tests commenced a year ago have been finished and the results are nearly ready for publication. The samples include coal of two sizes from each of three mines and smaller samples stored under water. Weathering tests in coöperation with W. L. Abbott of the Commonwealth-Edison Company, Chicago, are also under way. Studies in spontaneous combustion have been started by Mr. Wheeler for the Experiment Station. The preliminary results indicate that coal stored in heaps takes fire much below usual combustion temperatures. This increases the difficulties in the way of coal storage but does not necessarily preclude success.

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[1] Trans. Amer. Inst. Mining Engineers, Chatanooga Meeting 1908.

In the report of 1907 the following regarding the desirability of certain investigations in mining technology was printed: "It has been found impracticable at the present time, mainly owing to limitations of funds, to undertake certain highly desirable studies of the technology of the mining industry and of the geographical distribution of markets for Illinois coals. It is believed that much good would result from investigations along these lines and that certain portions of the work are well within the proper field of the State Geological Survey. It is now well known that there is, under present commercial conditions, an enormous waste in the mining of Illinois coal. In individual districts it has been estimated to amount to as much as sixty per cent, though of course such losses are not general. It would, however, probably be safe to say that in very many places forty per cent of the coal in the ground is left unmined or is ruined in the process of mining. In addition, the methods of mining introduced in recent years have greatly increased the production of fine sizes and have also, seemingly, increased the danger to life and property in the mines. The causes for all these losses are complex, and it is not to be supposed that either operators or miners willingly submit to them. Neither is it to be expected that the losses of life and property can be entirely done away with. At the same time experience has abundantly proven that careful and impartial investigations of such conditions will point the way to the remedying of some at least of the abuses, and in view of the enormous importance of the subject to the State and the public at large, such studies are believed to be amply warranted. Fortunately it now seems likely that the United States government will take up a general study of the most complex of the problems—causes and preventions of explosions and other accidents in mines. This still leaves, however, many important local problems to be investigated; problems that are in no way national, and it is hoped that the State Survey may be given the means of taking them up.

"The expansion of markets for Illinois coal is a matter of vital importance to the coal industry and indirectly to the people of the entire State. One of the most important means of promoting this expansion is by removing certain misapprehensions as to the quality of the coal and the pointing out of better means of burning, so as to increase its efficiency and decrease the smoke produced. This work has been taken up vigorously by the Engineering Experiment Station, which has published excellent bulletins on 'How to burn Illinois Coal Without Smoke," and other similar subjects. In addition to this valuable work, there should be investigations of the actual markets for the different grades of coal and of possible enlargements of these markets. There are large areas to the northwest within which Illinois washed coals might profitably supplant eastern coals now being sold. There are other areas to the south and west where, with proper organization of transportation agencies, even in advance of improvement of the rivers, trade territory could be gained. Any widening of the market would be of large benefit to the local industry, particularly if the summer market could be increased. For this reason the studies now under way relating to weathering of coal and coal storage are especially important."

Since the above was written the study of mine accidents has been taken up by the Federal government and a branch station has been established at Urbana for the demonstration of apparatus and methods of rescue. It is believed that this will do much to decrease the number of accidents and of fatalities. The general problems, however, of regular underground work and of better markets for our coal remain untouched. The last is peculiarly a local problem and it is believed much good would be accomplished by collecting and disseminating correct information regarding it. No elaborate investigations are called for but one or more men should be employed for so long a time as may be necessary.

Clay.—The clay-working industries of the State are in satisfactory condition. In 1907 the total output was valued at $13,220,489.00. In 1908 the output was as large but owing to lower prices the total value may prove to have been less. The principal business is as yet the manufacture of low priced products; building and paving brick and structural materials. These industries have grown with the population until Illinois now ranks fourth in total output of clay wares. It is to be expected that with increased wealth and leisure, the per capita consumption of these and higher priced lines of manufactured goods will increase. With our wealth of raw material and fuel it is possible to manufacture to advantage much that is now imported and at some future time it cannot be doubted that this will be done. In the meantime as evidence of the satisfactory economic basis of our brick industry it may be mentioned that one of the larger plants now ships standard building brick into territory extending from New York to St. Paul and that despite the business depression many of our plants ran full time and some even refused orders in 1908.

Within the year the report upon Illinois Paving Brick and Paving Brick Clays, prepared in coöperation with the Department of Ceramics by Messrs. Rolfe, Purdy, Talbot and Baker was published. This report is based upon careful studies not only of our paving brick and clays but also of those with which they come in competition and which are marketed in Illinois. The results of elaborate studies show that Illinois clays and paving brick compare favorably with those of neighboring states. In addition Mr. Purdy's tests show a relation between the specific gravity of the test pieces burned at different degrees of heat, and the qualities of the resulting brick, so that a way is now open for testing at comparatively slight expense and with considerable security as to results, the various clays believed to be suitable for manufacture in pavers. The other important results of the work may be summarized as below:

(1) The origin of clays and their relation to the parent rock and the processes by which the rock is changed to clay, are discussed in detail.

(2) It is shown that by suitable treatment it is possible to make satisfactory pavers from a large number of clays that were previously held to be unavailable.

(3) It is shown that suitable clays occur widely distributed throughout the State and that probably no considerable area is wholly destitute of satisfactory clays.

(4) Many analyses and physical tests have been made on type clays with interesting advances in scientific and technical knowledge.

(5) An accurate series of comparative tests of a large number of paving bricks are described and valuable suggestions are given for the improvement and refining of the methods of testing.

(6) The methods of constructing and caring for brick pavements are presented in simple statement suitable for general use and methods of cheapening the cost of such pavements are pointed out. This is of particular importance in view of the large number of cities and towns which will always use brick paving.

The report as a whole is a very valuable addition to the rapidly growing series of bulletins.

The new work for the year involved the collection and study of clays of the State available for use in making Portland cement as detailed elsewhere. Since the sampling and analysis of these clays has involved considerable expense, and since they are representative of considerable bodies of clay well situated for development, it is proposed to continue their study by making general burning tests and other experiments designed to determine their range of usesfulness. E. F. Lines has been assigned to this work.

The general study of the clays of the State involves the difficult problem of adequate sampling the undeveloped deposits. Grab samples are worse than useless and samples of weathered outcrops give results which are deceptive. We are frequently called on to furnish data regarding the occurrence of clays suitable for special purposes, such as convertor linings, retort-making, and other refractory wares. The data at hand do not often permit of an adequate answer to these inquiries and the specimens sent in by land owners are not often serviceable because of defective sampling. Illinois contains much good clay. The preliminary general studies of the stratigraphy of the deposits and of methods of testing have been carried out. These should be followed by more detailed field studies accompanied by adequate sampling and laboratory tests, which are beyond the means now at the disposal of the survey. It is hoped that some adequate provision may soon be made for this work.

Cement Materials.—In 1907, the State produced Portland and natural cement to the value of $2,725,326.00. The investigation of the cement materials of the State begun in that year was continued with the special object in view of determining the location and quality of deposits of clay and shale to be mixed with the limestones already analyzed. This work was under the immediate direction of A. V. Bleininger who was assisted by F. E. Layman. Mr. Layman visited all the localities where the work of the previous summer showed the occurrence of limestone suitable for making Portland cement, and collected samples of the clay most available for mixing with the limestone. This involved careful work since it was necessary to get an adequate quantity of unweathered material from a deposit suitably situated for development and large enough to furnish a supply for some years. About 100 pounds of clay, representing a much larger quantity of material collected in the field, were shipped to the laboratory for each locality. This was quartered down and subjected to analysis and test. The results of the work as a whole will, it is believed, furnish an accurate guide to our very important deposits of Portland cement making material, though no attempt has been made to sample every promising outcrop. The report is being prepared for the press by Messrs. Bleininger, Layman and Lines.

Portland cement is one of the most widely useful of modern building materials. The growth of the industry from 42,000 barrels in 1880 to 48,785,390 barrels in 1907 is one of the great industrial developments of America. In the opinion of many competent judges the future development will be even greater than that of the past. The exhaustion of our forests, with the natural desire of an older and richer people to build better, the wide increase in the variety of uses for cement, the desirability of conserving our iron and steel, and the fact that our permanent improvements both public and private are still largely to be built, all point to an increasing demand for cement. Illinois with its favorable situation regarding raw materials, fuel and transportation ought to look forward to supplying not only its own needs but those of much of the territory to the north and west. It is a pleasure to be able to state that our investigations show an abundance of material of suitable quality in situations favorable for development and to predict that a successful and expanding industry will follow. The excellent plants now in operation will necessarily not only be increased in size but supplemented by others to meet the future demands of the market.

Quarry Products.—Within the last season no attempt has been made to carry forward the special studies of quarry products. In 1906 and 1907 a number of quarries were visited and in coöperation with the State Highway Commission the availability of the rock for highway construction was determined. Many more quarries and natural outcrops remain to be sampled, but with the force now available it is impossible systematically to carry forward this work. The importance of these studies is large since in many parts of the State it is extremely difficult to get local materials for road making. Aside from this is the fact that large sums of money are annually sent out of the State for the purchase of building stone. If our own materials were thoroughly understood and completely utilized much of this money would be kept at home. The survey has already brought to light considerable bodies of oolite and other building stones which are apparently well situated and of suitable grade for quarrying. A special investigation of them with adequate sampling and complete tests is much needed. At present the largest local use of stone is for concrete. It can not be doubted that the demand for this purpose will rapidly increase and with this in view it is highly important to determine as promptly as possible the locations and character of all our stone resources.

Water Resources.—Water is our most important mineral, the one most vital to our health and prosperity, the one without which life itself would become extinct. The importance of properly regulating the supply was well shown in 1908 in the southern counties of the State, where, following a period of unusual flood, came a period of unusual drought. Then streams ceased to flow. The ordinary wells and other sources of supply were taxed to the limit, and in many cases failed altogether. Coal washers and factories were shut down, street and interurban cars ceased to run, and in places the supply was barely sufficient for the actual necessities of health and sanitation. The whole industrial machinery of the region was disarranged. If such conditions follow a drought in this area now, it may be well asked what will happen as the population increases in density. It is estimated that in the next century from three to four times as many people must be accommodated in our present territory and with that population a drought such as occurred this year would entail great suffering, despite the fact that Illinois lies within the area of abundant rain fall. It is not that the total supply of water is inadequate but its distribution is not satisfactory. With increasing density of population also, the difficulty of procuring uncontaminated drinking water is rapidly increasing and often the problem of securing adequate and suitable water for industrial purposes in favorable locations is a severe one.

With many of these problems the Geological Survey has no direct concern, the responsibility resting rather on the State Water Survey, the Internal Improvement Commission or the Board of Health. As relates, however, to the problem of distribution of water in the rocks below surface, the Geological Survey has direct concern. To the study of this phase of the general problem of water supplies J. A. Udden has been assigned. His work involves the study of underground water horizons by means of outcrop studies and the usual collection and study of deep well drillings. In the past season he has especially studied the area lying between the Illinois and Mississippi rivers. Already several hundred drill records are available. It is, however, especially desirable that this work should be based upon first hand knowledge of the drillings themselves. To that end arrangements will be made with any individual or municipality contemplating deep drilling in the State, for examination of the work. Directions for taking the samples and bags for sending them to the laboratory will be furnished. All needed laboratory tests will be made without charge and all possible information will be furnished to the well owner.

In certain portions of the State it is even now possible to furnish quite accurate forecasts as to depth, quality and quantity of water available. Each new well, where the samples have been carefully taken and studied, extends the area within which such forecasts are possible and increases their accuracy. The survey will therefore welcome correspondence with persons contemplating drilling.

In much of the State the deeper waters are not suitable for industrial purposes and their corrective treatment is a problem for the State Water Survey. Elsewhere the waters while suitable are not present within practicable drilling depths or are inadequate in quantity to the uses of a large community. For the smaller cities, however, or for single industries deep wells are often capable of furnishing a satisfactory supply. The complete investigation of these problems is necessarily a matter of some years. A beginning has been made in a special study of the water resources of the East St. Louis district,[1] and in the preparation, in coöperation with the State Water Survey, of a report upon Mineral

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[1] Bull. No. 5, Postage 6 cents.

Content of Illinois Waters.[1] Mr. Udden's investigations will furnish much needed additional data which will be published in special reports from time to time, similar to his paper on the artesian wells of the Peoria district.[2] This work is being carried on in coöperation with the U. S. Geological Survey which makes a small allotment toward the expense in order to permit its extension where desirable into adjacent states.

Oil and Gas.—In 1904 there was no recorded production of oil in Illinois. In 1905 the Eastern Illinois oil fields were discovered and 156,502 barrels were shipped by tank cars. In 1906 pipe lines were extended into the area, 4,397,050 barrels of oil were shipped and the State ranked ninth. In 1907 there was a large increase of production, the State ranking third with a total output of 24,540,938 barrels. In 1908 there was another increase, the total shipments for the year reaching approximately 40,000,000 barrels. The principal production is from Clark, Crawford and Lawrence counties in the southeastern part of the State, the oil occurring in the Pennsylvanian, Pottsville and Chester rocks of the carboniferous. Immediately after the organization of the survey the study of these fields was taken up and several papers describing the territory have been published[3] complete reports are yet to be written.

Of prime importance in any final report on an oil field is an accurate knowledge of the relative elevation of the various oil sands. With this in view a special party was organized in 1906 to run level lines through the northern portion of the field, and the elevations were indicated by suitable bench marks. The next year regular topographic work was taken up and surveys were made of the field between the Indianapolis Southern and B. & O. S. W. railway lines. In the season of 1908 the levels were extended south to connect with those previously run in the Mount Carmel area.

Supplementary to this topographic work R. S. Blatchley, assisted by Douglas Wright and J. C. Jones, collected drill records throughout the Hardinsville quadrangle and accurately determined the elevation of approximately 2,800 wells. Since the close of the season these drill records have been plotted and are now being studied, in order to construct maps showing the depths to the various sands, and the recorded thicknesses of the latter. It is believed these maps will be of large service in the further development of this important field and also that they will yield valuable data for the study of the laws governing the genesis and accumulation of oil and gas. In the present unsatisfactory condition of our knowledge of these laws and of the structure of the State it is impossible to make accurate forecasts. It is believed that with the more complete data now being collected this will become possible, at least in some cases.

Throughout the oil fields a certain amount of gas is found with the petroleum. The gas is now being used in the surrounding towns and in pumping oil. The individual wells have good pressure and volume but in the main they have so far proven short lived so that the gas is relatively of much less importance than the oil. However, the value of the product for 1907 reached $143,577.00. Outside the main field, gas has been found at a number of points and utilized at several small towns. In Pike county it occurs in the Niagara over a considerable area but with small pressure. In other places it is found in the Pleistocene or drift deposits and its pressence is not necessarily indicative of large supplies or of the presence of oil at deeper horizons. C. F. Knirk has furnished a special report on gas pockets of this character.

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[1] Bull. No. 10. In press.

[2] Bull. No. 8, Year Book for 1907, pp. 313-334.

[3] Petroleum in Illinois, by A. W. Lewis, Mining World, Apr. 14, 1906.
Petroleum Industry of Southeastern Illinois, by W. S. Blatchley, Bull. 2, State Geol. Survey, 1906.
Petroleum Fields of Illinois in 1907, by H. F. Bain, Bull. No. 8, State Geol. Survey, pp. 273-312.

Both oil and gas in the rock have been found at a number of places in the southwestern part of the State; notably at Sparta, Centralia and in the East St. Louis district. A large amount of prospecting is now being carried on throughout the State and the survey is called on almost daily for information regarding the probable depth to the various oil sands and regarding the presence or absence of anticlinals. It is usually possible to give a fair estimate of the depth to the sands, but our data regarding geologic structure is not so complete. Structural features which are very slight, measured in feet, are here of very large importance as regards the accumulation of oil and gas. For this reason it is necessary to have a complete restudy of all the available drill records with exact data regarding their elevation. Many of the records now on file were made years ago and are of unequal accuracy. In few cases were the samples or drill core examined by competent geologists and accordingly there are many errors. New records are being collected as rapidly as possible and the elevation of both old and new test holes determined by reference to railway or other lines of levels. It is proposed to make a preliminary structural map of the State in advance of the detailed surveys. Such a map will be particularly useful in future prospecting for oil and gas. Good progress is being made but probably another season must be devoted to the work before any general results are available for publication. In the meantime Jon Udden has made a special study of the Duquoin area within which there is a certain amount of faulting and a small structural area of some possible significance in the finding of gas and oil.

Educational Bulletins.—The law governing the State Geological Survey, by the provision it makes for the consideration of "Scientific and economic questions * * * deemed of value to the people," and the provision that materials collected shall be distributed to "the educational institutions of the State in such manner as the commissioners may determine to be of the greatest educational interests of the State," indicases plainly that it was the purpose of the General Assembly to provide for the educational as well as economic phases of the survey work. In harmony with this idea, plans were early made for a series of bulletins available for use in the schools, which should put in simple form, the fundamental facts regarding the physical geography of our areas. Professor Salisbury of the University of Chicago was placed in charge of the work and seven typical areas were selected for special study. Reports upon all of these have been prepared and are available whenever the printer can handle them. The first of the reports, that on the physical geography of the Evanston-Waukegan region by Messrs. Atwood and Goldthwait was published as Bulletin 7. This has proven to be one of the most popular publications of the survey, being favorably received by educators everywhere. It is being quite generally used in the schools of the area treated and there is a large demand for it elsewhere. Unfortunately this demand was not anticipated and the edition printed proved much too small. It will be necessary to print a second. In the meantime six similar reports are ready, and field work of this sort has been temporarily discontinued until the printing can be brought up to date.

Miscellaneous Mineral Resources.—Within the State there are a large number of minor minerals of which there is or may be a considerable output. Galena and blende, the common sulphides of lead and zinc are mined in both the northern and southern parts of the State and are known, though not as yet in commercial quantities, in the western and southwestern counties. A small amount of silver is found with the lead in the southern counties. In 1907 (according to the U. S. Geological Survey) the total values for the State were: Silver, $1,882.00; lead, $87,980.00; zinc, $86,966.00. In 1908 preliminary estimates by the Mining World indicate that 2,017 tons of blende and 93 tons of galena were shipped from JoDaviess county as compared with 2,530 and 620, respectively for 1907. In the southern part of the State the production of zinc ore is irregular and some galena is produced as an incident to fluorspar mining in Pope and Hardin counties. The fluorspar mines are among the most important in the world and yielded, in 1907, 25,128 tons selling for $141,971.00. The introduction of the open-hearth method of steel making in the place of the Bessemer process is increasing the demand for spar and promises an increasing output.

Pyrites, the sulphide of iron, occurs widely disseminated but is rarely in commercial quantities. A small amount is saved as a by-product of zinc and lead mining and at one of the coal mines of the State, at least, the "sulphur balls" are hand picked and sold for making sulphuric acid.

Silica, in the form of a weathered chert, is found in the Devonian beds of Union and Alexander counties. It is used for a variety of purposes and is probably capable of being used for many others. The stratigraphy of the deposits is being studied by T. E. Savage, while T. R. Ernest of the Engineering Experiment Station is experimenting with the material.[1]

Ochre and paint pigments of various sorts are found at a few places in the State but are very little used. Sampling and testing the materials would probably lead to the development of some of the deposits.

Glass sand of high grade is taken out at Ottawa and shipped widely. It is probable that sand suitable for lower grades of manufacture occur at other points in the State. These deposits, as also sand for building, moulding and other uses should be studied.

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[1] State Geol. Survey, Bulletin No. 8, pp. 147-149; Bulletin No. 4, pp. 185-186.

Whetstones are found in the southern part of the State and it is known that the formations from which these stones are taken in Indiana, extend into our State. Preliminary samples indicate that portions at least of the material are of commercial grade.

Mineral Statistics.—One of the most important aids to the economic development of an area is the publication of accurate statistics of production. The survey is therefore coöperating with the U. S. Geological Survey in the annual collection and publication of the statistics of output of our mineral industry. For the year 1907 the plan adopted was that of the previous years, the State Survey undertaking to look up the delinquent producers and the Federal Survey carrying on the main correspondence. Mr. F. B. Van Horn acted as special agent and prepared Circular No. 4, containing a resumé of the production for 1907. It was preceded by Circular 3, giving the special statistics of the petroleum industry. Since these reports were gotten out at the earliest possible moment they were not complete with regard to minor products, and slight corrections are included in the figures in this report.

In collecting the figures for 1908 the plan has been changed and the inquiry blanks are in the main sent out by, and returns made to, the State Survey; the returns after tabulation being forwarded to Washington. There are now on the mailing lists 2,040 producers and the output includes coal, coke, clay, pottery, brick and tile, stoneware, sand-lime brick, flourspar, sandstone, sand and gravel, mineral paints, mineral waters, limestones, gas and oil. The figures for 1908 are not yet complete. Apparently they will indicate no notable increase or decrease over those for 1907. For the latter year the complete totals for Illinois, according to the U. S. Geological Survey, were as follows:

	1906	1907
Coal	$44,763,062	$44,687,382
Coke	1,205,462	......
Ammonium sulphate Coal tar Gas, illuminating Gas, coke	2,720,641a	......
Iron, pig	47,128,000a	52,229,000
Petroleum	3,274,818	16,432,947
Clay	131,272	......
Clay products	12,634,181	13,220,489
Stone	2,961,456	3,789,342
Cement, Portland	2,461,494	2,632,576
Sand and gravel	886,357	1,215,034
Lime	534,118	559,305
Glass sand	156,684	152,619
Natural gas	87,211	143,577
Fluorspar	160,623	141,971
Cement, natural	118,221	92,750
Mineral waters	77,287	91,760
Lead	65,208	61,628b
Zinc c	34,404	37,728b
Silver	......	1,900
Other products	1,787,807d	154,396e
	$121,188,306	$145,644,404

a Estimated.

b Mine values.

c Zinc produced in State, in part from ore shipped in: 1906, $5,499,508; 1907, $6,614,608.

d Includes alum and aluminum sulphate, slag cement, infusorial earth, sand-lime brick, Venetian red, and white lead.

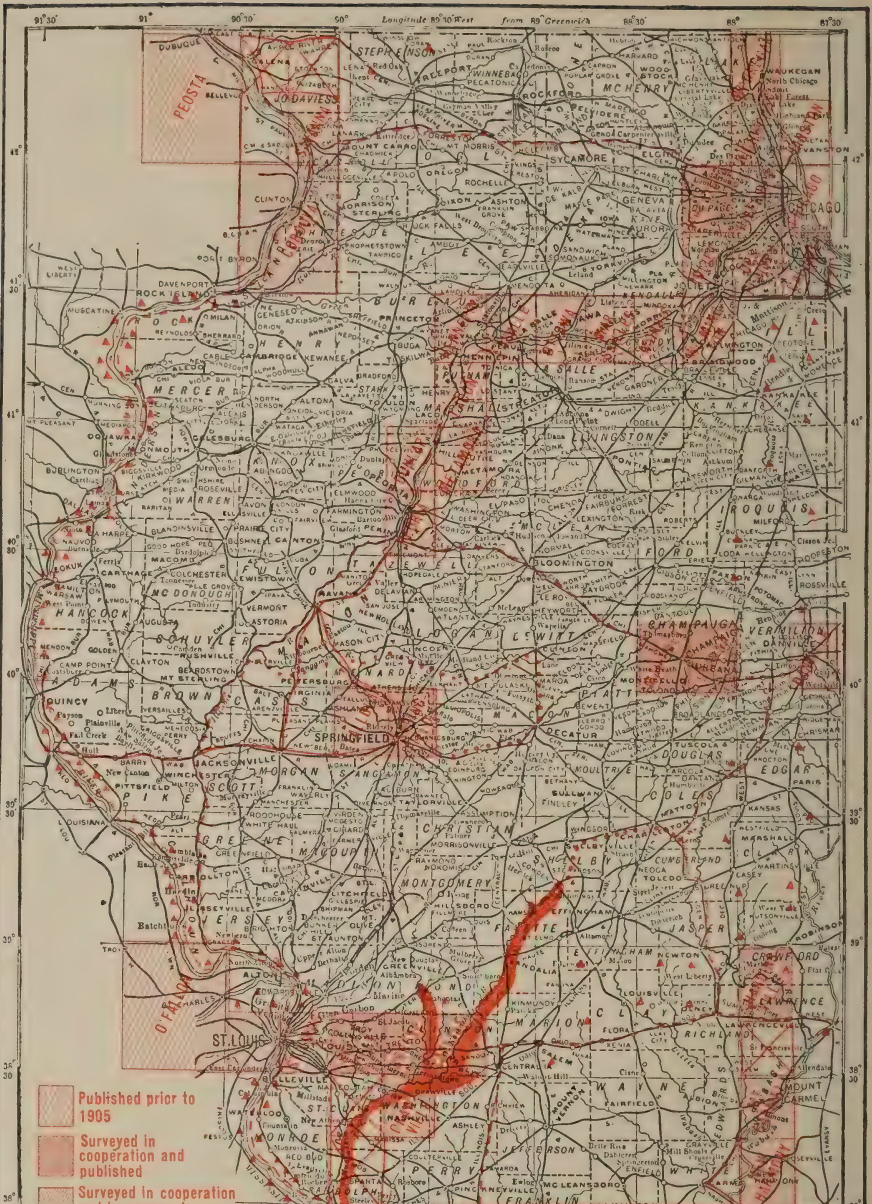
e Includes slag cement, infusorial earth, metallic paint, pyrite, quartz, sienna, umber, sand-lime brick.

Bureau of Information.—One of the most important functions of the survey is to furnish information regarding the mineral resources of the State to land owners, miners, investors and educators. A large amount of time is devoted to this work, and a great deal of correspondence is involved. The requests for information come from all parts of the country and from every part of the State. The recent requests from within the State are tabulated below. Approximately an equal number of inquiries have come from other states and countries.

REQUESTS FOR INFORMATION.

County.	Number of Inquiries.	County.	Number of Inquiries.	County.	Number of Inquiries.
Adams	11	Hancock	10	Morgan	7
Alexander	7	Hardin	4	Ogle	2
Bond	2	Henderson	2	Peoria	8
Bureau	1	Jackson	6	Perry	2
Carroll	1	Jasper	9	Pike	5
Cass	8	Jefferson	3	Pope	7
Champaign	5	Johnson	1	Pulaski	3
Christian	1	Jersey	1	Randolph	4
Clark	9	Jo Daviess	3	Richland	2
Clay	1	Kane	4	Rock Island	1
Clinton	6	Kankakee	4	Saline	4
Coles	7	Kendall	2	Sangamon	27
Cook	90	Knox	6	Schuyler	4
Crawford	11	Lake	2	Scott	1
Cumberland	1	La Salle	2	Shelby	1
DeKalb	1	Lawrence	9	St. Clair	10
Dewitt	1	Logan	1	Stark	1
Douglas	2	McDonough	8	Stephenson	2
Dupage	2	McHenry	1	Union	11
Edgar	3	McLean	4	Vermilion	9
Edwards	2	Macon	9	Wabash	3
Effingham	9	Macoupin	6	Washington	1
Ford	2	Madison	18	Wayne	4
Franklin	4	Marion	9	White	2
Fulton	4	Mason	1	Whiteside	1
Gallatin	6	Massac	1	Will	1
Greene	5	Mercer	1	Williamson	6
Grundy	1	Monroe	3	Winnebago	2
Hamilton	1	Montgomery	12	Woodford	1

Subject.	No. of Inquiries.	Subject.	No. of Inquiries.
Altitudes	4	Limestone	8
Areal surveys	7	Manganese	1
Asphalt	1	Maps	49
Bauxite	2	Mica	1
Cement	4	Mineral	68
Chalk	1	Miscellaneous	15
Chert	2	Oil	66
Clay	30	Paint materials	1
Coal	65	Pearls	1
Copper	4	Peat	6
Drainage	4	Phosphate	2
Fluorspar	9	Sand	4
Galena	2	Sandstone	1
Gas	22	Shale	1
Geology, general	4	Silica	3
Gold	1	Soil	1
Granite	2	Stone	7
Graphite	2	Swamps	2
Gravel	4	Trenton rock	1
Gypsum	1	Water	8
Iron	3	Wells	8
Koalin	1	Zinc	6
Lead	7	Zoölogical	3
Lime	2		



Map showing progress of Topographic and Drainage Surveys.

These lists illustrate sufficiently perhaps the wide variety of subjects and the general nature of these requests for information. In making this table no account has been taken of the numerous requests for printed reports. The list includes only the cases requiring the preparation of a manuscript report or letter. It is not possible in all cases to give the information asked for. Often, indeed, the information does not exist. In other cases it would require expensive field studies to solve the particular problems involved. In such cases it is only possible to file the request for investigation the first time one of the field men is in the vicinity in the course of regular work.

In many cases the request for information is accompanied by a specimen for analysis or test. Usually the specimen has not been well chosen, and an analysis would not signify much with regard to the deposit as a whole. It is not generally understood that sampling is quite as important, and calls for nearly as much skill, as making analyses or laboratory tests. This is entirely aside from the honesty of the one taking the sample and his desire to get an average speciment of the material. Analytical work and laboratory tests are expensive, and it desirable not to spend money on them except on the basis of good sampling. For these reasons, together with the fact that any other course would permit the whole appropriation to be used up by any citizen for private purposes, or for work of doubtful value, the survey has been forced, in most instances, to decline to make any analyses or laboratory tests on miscellaneous material sent in by correspondents. While this occasionally leads to individual disappointment, it seems to be the only plan consistent with the present size of the appropriations, the general purpose of the survey—a systematic study of the mineral resources of the State. In many cases it is not necessary to make an analysis in order to determine the value of the material, but the results of a physical examination are cheerfully and promptly furnished the inquirer.

Topographic Section.

(By W. H. Herron.)

The plans for the coöperative topographic surveys in Illinois for the season of 1908, contemplated the completion of the topographic sketching of unfinished quadrangles begun in the previous year, the revision of the Hennepin and LaSalle maps, made previous to the inauguration of the coöperative survey, and the extension of the control, both primary and secondary, over areas to be completed in the near future. The general progress of the work is shown on the accompanying map.

It will be noted that the localities selected for this year's work are widely divergent, the Galena and Apple river quadrangles being in the extreme northwestern corner of the State, the LaSalle and Hennepin in the north central portion, the Hardinsville, Bridgeport, Carmi and Shawneetown in the southeastern part, while the remainder of the quadrangles are situated in southern and southwestern Illinois. The distribution of the work has been conditioned by the needs of the mining industries of the State, there being an especially large demand for the maps in the coal, oil, and lead and zinc fields. The season has been an unusually favorable one, and the output has been most satisfactory.

It has been possible to utilize much of the primary control of the quadrangles in southwestern Illinois in the drainage surveys of the Kaskaskia and Big Muddy rivers, thus avoiding duplication of work, and accomplishing a saving of funds for the drainage surveys.

A summary of results of the coöperative topographic surveys in Illinois during the season of 1908 is shown in the following table:

LOCALITY.	Square miles of topography.	TRAVERSE, MILES.		B. M.	LEVELS, MILES.	
		Primary.	Secondary.		Primary.	Secondary.
Apple River	...	...	696	10	71	...
Baldwin	...	55	594	11	78	...
Bridgeport	...	55	...	19	91	321
Carlyle	156	...	...	...	...	102
Carmi	...	74	345	19	84	...
Galena	...	...	408	11	48	...
Hardinsville	139	...	37	...	...	...
Hennepin	...	62	556	18	67	...
Herrin	105	...	50	...	...	...
LaSalle	...	62	686	20	73	...
Murphysboro	236	...	97	...	...	576
New Athens	...	...	...	...	...	462
Okawville	165	...	25	10	30	388
Shawneetown	...	36	...	3	...	...
Vandalia	101	...	539	...	...	...
	902	344	4,033	121	542	1,849

It will be noted from a perusal of the above table, and comparing it with that published for 1907,[1] that the Carlyle, Hardinsville, Herrin, Murphysboro and Okawville quadrangles will be ready for publication as soon as the office drawings are completed, the field work having been entirely finished for these areas. The New Athens sheet needs only the topographic sketching in order to complete the field work for this quadrangle. The secondary leveling and topographic sketching are necessary to finish the Apple river, Galena, Hennepin and LaSalle quadrangles, while the secondary traversing and sketching will complete the Bridgeport sheet.

The following is the personnel of the organization arranged by quadrangles:

Apple River—Henry Bucher, levelman; F. B. Barrett, field assistant; Terry Hackett, rodman; M. F. Gannett, field assistant.

Baldwin—W. A. Gelbach, levelman;; F. W. Crisp, field assistant; L. S. Bowles, rodman.

Bridgeport—W. A. Gelbach, junior topographer; W. S. S. Johnson, levelman; A. J. Hendley, levelman; Percy Kimmel, levelman; J. M. Aiken, rodman; L. S. Bowles, rodman; Mack McCreery, rodman; Thos. Gassoway, rodman.

Carlyle—A. T. Fowler, assistant topographer; E. W. McCrary, assistant topographer; A. J. Hendley, levelman; A. C. Wood, levelman; Thos. Gassoway, rodman; F. W. Hempstone, rodman.

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[1] Year book for 1907, Bull. No. 8, page 23.

Carmi—J. R. Ellis, assistant topographer; W. A. Gelbach, junior topographer; F. W. Crisp, field assistant; W. H. Snyder, recorder; L. S. Bowles, rodman; G. C. Graeter, rodman; N. Underwood, chairman; M. Underwood, rodman; F. P. Tippitt, laborer.

Galena—Henry Bucher, levelman; F. B. Barrett, traversman; F. W. Crisp, traversman; Terry Hackett, rodman; M. F. Gannett, field assistant.

Hardinsville—M. Hackett, topographer.

Hennepin—C. B. Kendall, assistant topographer; G. R. Hoffman, traversman; Henry Bucher, levelman; Terry Hackett, rodman; R. C. Gaylord, rodman; J. W. Matthewson, rodman; S. L. Fuller, rodman; M. F. Gannett, recorder.

Herrin—W. J. Loyd, topographer; G. L. Gross, junior topographer; J. A. Duck, field assistant; J. W. Lowell, Jr., field assistant; J. M. Aiken, rodman.

LaSalle—W. J. Lloyd, topographer; C. B. Kendall, assistant topographer; Henry Bucher, traversman; G. R. Hoffman, traversman; Terry Hackett, rodman; R. C. Gaylord, rodman; J. W. Matthewson, rodman; S. L. Fuller, rodman; M. F. Gannett, recorder.

Murphysboro—W. J. Loyd, topographer; G. L. Gross, junior topographer; J. W. Lowell, field assistant; A. C. Wood, levelman; W. S. S. Johnson, levelman; Percy Kimmel, levelman; F. W. Hempstone, rodman; C. P. Gross rodman; Mack McCreery, rodman; J. W. Aiken, rodman.

New Athens—A. C. Wood, levelman; H. A. Church, levelman; A. J. Hendley, levelman; Thos. Gassoway, rodman; Melvin Evenson, rodman; F. W. Hempstone, rodman; C. P. Gross, rodman.

Okawville—W. J. Lloyd, topographer; E. W. McCrary, assistant topographer; W. A. Gelbach, levelman; A. J. Hendley, levelman; A. C. Wood, levelman; H. A. Church, levelman; L. S. Bowles, rodman; F. W. Hempstone, rodman; Thos. Gassoway, rodman; Melvin Evenson, rodman.

Shawneetown—J. R. Ellis, assistant topographer; W. H. Snyder, recorder; N. Underwood, chairman; M. Underwood, rodman; F. B. Tippitt, laborer.

Vandalia—E. W. McCrary, assistant topographer; Lee Morrison, junior topographer; E. L. Hain, junior topographer; A. K. Atkinson, field assistant.

The following table shows the season's expenditures:

Balance Jan. 1, 1908	....	$ 3,294 18
Appropriation, United States, net	$7,920 00	
Appropriation, State, net	6,920 00	
		14,840 00
Total funds available	....	$18,134 18
Disbursed Jan. 1 to Dec. 31, 1908—		
Office	$ 1,820 79	
Field	14,775 78	
		$16,596 57
Balance Jan. 1, 1909—		
United States	$ 305 25	
State	1,232 36	
		$1,537 61

The office expenditures indicated were from the unexpended balance of last year, and the work consisted of the completion in the office of maps of the previous season.

DRAINAGE SECTION.

Organization and Work.—The special drainage section of the survey was organized in 1907 to take charge of the work provided for by the appropriation for the survey and study of the lands subject to overflow along our inland rivers. The need of this work has been recognized for some years. According to estimates made for the State Geological Survey by W. Carvel Hall, there is an enormous area of land subject to overflow along our intra-state streams.

BOTTOM LANDS SUBJECT TO OVERFLOW IN ILLINOIS.

(ESTIMATE BY W. CARVEL HALL.)

River.	Estimated valley length—miles.	Estimated area of bottom land—square miles.
Embarrass	65	175
Little Wabash	85	335
North Fork Little Wabash	20	45
Skillett Fork	40	190
Olney Fork	17	15
Saline River	25	30
Big Muddy	50	45
Kaskaskia	65	245
Silver Slough	22	30
Shoal Creek	25	40
Crooked Creek	7	5
Sangamon	80	100
Salt Creek	15	20
Desplaines	285	900
Rock	80	275
Spoon	60	30
Mackinaw	30	25
Pecatonica	45	45

In this table are included only those streams which were unsurveyed. If to the areas estimated are added the bottom lands of the Illinois and its branches, surveyed by the U. S. Army Engineers in 1905,[1] and the Cache river bottoms surveyed by a State commission in 1904,[2] the totals would be much greater. Preliminary surveys have already shown that Mr. Hall's estimates are well within the truth since on the Kaskaskia alone nearly 300 square miles of bottom land are now known. The table however, will serve its main purpose in illustrating the extent and something of the distribution of the bottom lands of these streams.

The great interstate rivers which border Illinois, the Mississippi, Ohio and Wabash, have also extensive bottom lands. Mr. Hall estimates that in Illinois their areas amount respectively, to 1,205, 25 and 270 square miles.

Probably ninety per cent of the bottom lands of the State are unprotected or inadequately protected against floods and it is estimated that if they could all be brought under successful cultivation there would be added to the farm value of the State over one hundred million dollars. There would be additional benefits to be derived from improved health conditions, some power development and the increased navigation of the streams.

In order properly and economically to plan works which shall protect and drain the river bottom it is necessary to take into account the river as a whole. Power development must not be allowed to interfere with navigation and one drainage project must not be allowed to block the way for a more comprehensive one. No permanently satisfactory solution of the problems afforded by even one of these streams is likely to be reached except by the united action of the people of a whole valley. Large districts must be arranged and in order that they may work most efficiently, it will probably prove necessary for the State to assume at least supervisory control of the work. The State is, in fact, under certain obligations to do this. The lands, originally in possession of the general government, were given to the State upon condition that they be drained. This obligation was pased on to the counties, drainage laws being provided to permit of the work being executed. Since now a stage in the work has been reached where a considerable change in method is necessary, the State must assume its share of the burden.

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[1] House of Rep., Doc. 263, 59th congress, first session.

[2] Report of Board of Cache River Drainage Commission of Illinois, 30 pages, Danville, 1905.

A beginning has been made. In 1903 the General Assembly provided for a special survey of the Cache river bottoms. In 1905 the General Assembly passed a joint resolution looking to the improvement particularly of certain of the rivers in the southern part of the State. No definite results having been accomplished under this resolution, the General Assembly in 1907 made a special appropriation to the State Geological Survey for the survey and study of lands subject to overflow along the streams of the State. At the same time an additional appropriation was made to the Internal Improvement Commission for the further study of the rivers of the State with a view especially to their improvement from the point of view of navigation and the development of power. The State has therefore undertaken, as its share, the expense of the surveys, the studies and the supervision of the work, and, in appropriating for the Shawneetown levee, has even set the precedent of at least come appropriation for construction work.

To consider the various problems involved in river improvement in Illinois, there has been organized a State Committee on Waterways Reclamation, including representatives of the State Geological Survey, the Internal Improvement Commission, and the U. S. Department of Agriculture. The work of this joint committee is expected to result in a report upon which the General Assembly can formulate a definite policy toward stream improvement. The making of detailed maps of the different river valleys has been assigned to the Geological Survey, and is now being carried on. A report bv Mr. E. W. McCrary, detailing the progress for the year, is given on the following pages. The methods used are essentially those developed by the U. S. Geological Survey, which is actively coöperating in the work.

Work is now being carried on along the Kaskaskia, Big Muddy and Embarrass and additional work along the Little Wabash and the Sangamon is planned. The special study of drainage problems will be undertaken by the U. S. Department of Agriculture, under the direction of Mr. C. G. Elliott, Chief Engineer of Drainage Investigations. Work has already been taken up along the Little Wabash river and Skillet fork.

The Internal Improvement Commission is making the general engineering studies involved, including the gauging of the streams, in which part of the work the assistance of the water resources branch of the U. S. Geological Survey has been enlisted. A report upon these phases of the work will be made by the Internal Improvement Commission.

Surveys for 1908. (*By E. W. McCrary.*)—The topographic survey of overflowed lands, begun in 1907, was continued through the season of 1908, resulting in complete surveys of the Kaskaskia river from the wagon bridge, one and one-half miles southeast of Cowden, to its outlet near Chester; Shoal Creek, from the wagon bridge six miles west and one mile south of Greenville, to its outlet into the Kaskaskia river; and the Big Muddy river from near Mulkeytown to the Mississippi. The distance along the surveyed portion of the Kaskaskia river, by direct line through the bottoms, is 118 miles; Shoal Creek, twenty-nine miles, and the Big Muddy, fifty miles. The areas surveyed are shown on the accompanying map.

In addition to these completed maps, a primary level line has been run from Beardstown along the Sangamon river to Petersburg, and from Springfield to Decatur; from Decatur the line continues north along the Illinois Central railroad to Clinton, and thence west along Salt river to the Sangamon and south to Petersburg. This line of levels will serve as vertical control for the work along the Sangamon and Salt rivers.

The total area surveyed is 496 square miles, of which 348 are included in the Kaskaskia river survey, forty-eight in the Shoal creek survey, and 100 in the Big Muddy. Of the 348 square miles along the Kaskaskia river, 160 was surveyed in 1907, which leaves for 1908, a total of 336 square miles. There is an average of five linear miles of stadia traverse, with fifty determined elevations per square mile, which makes a total of 2,480 miles of traverse and 24,800 elevations, which are distributed along these streams as follows:

	Miles traverse.	Elevations.
Kaskaskia River	1,740	17,400
Shoal Creek	240	2,400
Big Muddy River	500	5,000
	2,480	24,800

In addition to the ground elevations, levels have also been taken of a sufficient number of high water marks to make it possible to show upon the completed maps, the extent of the flooded section. With this information plotted on the maps, it will be possible to see at a glance the extent of the flood along the entire length of the stream. Elevations have also been determined of the approximate low water, but because of the quick changes in the level of the water surface, and the lack of stream gauges, these elevations may vary as much as three feet from a given stage. However, they should be useful in giving a fairly accurate idea of the fall between different points along the stream.

In their completed form, the maps are divided into sections or sheets, which are given the name of the largest town, or, if there be no town, of the best known feature which it contains. The size of the sheets are not uniform, but necessarily vary in order to fit the changing course of the stream. The approximate size will be, to the scale of the map, 9 by 11 miles.

The scale is 1:24000, or one inch to 2,000 feet, and the contour interval, five feet. The methods used in the survey of these streams are fully given in the year-book for 1907.[1] During 1908 the work was carried along in practically the same manner as in the preceding year. Following is a list of the completed sheets:

Kaskaskia River—Lorton Bridge, Vandalia, Soper Lake, Carlyle, Santa Fé, Queens Lake, Fayetteville, Round Pond, Evansville.

Shoal Creek—Breese, Frogtown.

Big Muddy River—There will be five or six sheets along this stream. They were surveyed under the direction of Mr. W. J. Lloyd of the U. S. G. S., and are being put into map form by him.

Of these sheets, the Carlyle, Santa Fé and Queen's lake are now available. The Breese and Frogtown were completed February 1. The Vandalia, Soper Lake and Lorton Bridge are expected to be ready by March 1, and the remainder by April 1.

From the view point of area mapped, and the quality of the work, the year 1908 has been a successful one. However, the party in the field suffered a great deal from sickness during the summer months, there being only two out of a party of ten to escape sickness. Of the eight who were sick, five were affected at the same time, which very seriously interferred with the progress of the work. The work, as previously planned for 1908, included the Kaskaskia river, Big Muddy, Shoal creek, and a small section of the Little Wabash, south of Carmi, and the level work on the Sangamon. All of this, with the exception of the Little Wabash, was completed as planned.

The personnel of the surveying party is as follows:

Kaskaskia River—E. W. McCrary, assistant engineer; Lee Morrison, assistant topographer; E. L. Hain, assistant topographer; S. K. Atkinson, field assistant; A. L. Hambrecht, field assistant; H. P. Hancock, field assistant; R. E. Johnson, field assistant; John Fletcher, levelman; F. W. Hughes, traversman; P. E. Fletcher, traversman; W. H. Herron, Jr., rodman; Herbert Johnson, rodman; Douglas Wright, rodman; William Ahring, rodman; Ralph Atkinson, rodman; G. R. Hoffman, rodman; W. S. S. Johnson, rodman; J. W. Johnson, rodman; J. M. Aiken, rodman.

Shoal Creek—E. W. McCrary, assistant engineer; Lee Morrison, assistant topographer; J. A. Duck, field assistant; S. K. Atkinson, field assistant; F. W. Hughes, levelman; J. Lederer, rodman; Douglas Wright, rodman; William Ahring, rodman.

Big Muddy River—W. J. Lloyd, topographer; George Gross, assistant topographer; A. L. Hambrecht, field assistant; J. A. Duck, field assistant; R. E. Johnson, field assistant; W. H. Herron, Jr., rodman; Mack McCreery, rodman; W. S. S. Johnson, rodman; J. M. Aiken, rodman.

Plans.—It is greatly regretted that these surveys are not yet sufficiently advanced to permit definite recommendations for the improvement of these rivers to be submitted at this time. This phase of the subject is treated in the report of the Internal Improvement Commission.

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[1] Topographic Mapping in Botton Lands, by E. W. McCrary. Bull. No. 8, State Geo. Survey, pp 64-67.

PUBLICATIONS.

Reports Printed.—At the beginning of the year Bulletin 7, a report on the physical geography of the Evanston-Waukegan Region, by Messrs. Atwood and Goldthwait, was still in press. It was distributed in the spring, followed in the fall by Bulletin 8, the Year-Book for 1907. Bulletin 9, a special report on paving brick and paving brick clays, by Messrs. Rolfe, Purdy, Talbott and Baker, is now in press. Bulletin 10, a report on the mineral content of Illinois waters, prepared in coöperation with the State Water Survey, has been submitted for publication.

The reports now available for distribution are listed below:

Bulletin 1. The geological map of Illinois, by Stuart Weller. Including a folded, colored geological map of the State on the scale of 12 miles to the inch, with descriptive text of 26 pages. Gratuitous edition exhausted. Sale price, 45 cents.

Bulletin 2. The Petroleum Industry of Southeastern Illinois, by W. S. Blatchley. Preliminary report descriptive of condition up to May 10, 1906; 109 pages. Gratuitous edition exhausted. Sale price, 25 cents.

Bulletin 3. Composition and Character of Illinois Coals, by S. W. Parr; with chapters on the Distribution of the Coal Beds of the State, by A. Bement; and Tests of Illinois Coals under Steam Boilers, by L. P. Breckenridge. A preliminary report of 86 pages. Gratuitous edition exhausted. Sale price, 25 cents.

Bulletin 4. Year Book for 1906, by H. Foster Bain, director, and others. Includes papers on the topographic survey, on Illinois fire clays, on limestones for fertilizers, on silica deposits, on coal, and on regions near East St. Louis, Springfield and in southern Calhoun county; 260 pages. Gratuitous edition exhausted. Sale price, 35 cents.

Bulletin 5. Water Resources of the East St. Louis District, by Isaiah Bowman, assisted by Chester Albert Reeds. Including a discussion of the topographic, geologic and economic conditions controlling the supply of water for municipal and industrial purposes, with map and numerous well records and analyses. Postage, 6 cents.

Bulletin 6. The Geological Map of Illinois, by Stuart Weller. (Second edition). Including a folded colored geological map of the State on the scale of 12 miles to the inch, with descriptive text of 32 pages. It includes corrections and additions to the former map and text, and shows locations of mines where coal, lead, zinc and fluorspar are produced. The great oil fields of southeastern Illinois are also outlined. Gratuitous edition exhausted. Sale price, 45 cents.

Bulletin 7. Physical Geography of the Evanston-Waukegan Region, by Wallace W. Atwood and James Walter Goldthwait. Forming the first of the educational bulletins of the survey, and designed especially to meet the needs of teachers in the public schools; 102 pages. Gratuitous edition exhausted. Sale price, 25 cents.

Bulletin 8. Year Book for 1907, by H. Foster Bain, director, and others. Including administrative report; papers on the general geology and mineral production of the State; a directory of the clay industries; reports on stream improvement, land reclamation and topographic mapping; on field and laboratory sudies of coal, cement materials, oil, gas, lead, zinc and silica; 393 pages. Postage, 12 cents.

Bulletin 9. Paving Brick and Paving Brick Clays of Illinois, Geology of Clays, Geological Distribution of Paving Brick Materials in Illinois, and Clays Tested Which are Suitable for use in the Manufacture of Paving Brick, by C. W. Rolfe; Physical and Chemical Properties and Pyro-Physical and Chemical Properties of Paving Brick Clays, by Ross C. Purdy; Qualities of High Grade Paving Brick, and Tests Used in Determining Them, by A. N. Talbot; Construction and Care of Brick Pavements, by Ira O. Baker; 315 pages, 3 plates, and 33 figures. Postage, 13 cents.

Circular No. 1. The Mineral Production of Illinois in 1905. Pamphlet, 14 pages; postage, 2 cents.

Circular No. 2. The Mineral Production of Illinois in 1906. Pamphlet, 16 pages; postage, 2 cents.

Circular No. 3. Statistics of Illinois Oil Production, 1907. Folder, 2 pages; postage, 1 cent.

Circular No. 4. The Mineral Production of Illinois in 1907. Pamphlet, 16 pages; postage, 2 cents.

The distribution of these reports so as to prevent waste, and yet make them most widely available, has been in itself a considerable task. It was thought that the interests of all concerned would be best met if 500 copies of each report be reserved for sale at the cost of printing, the receipts from the sales being turned into the State treasury. This makes it possible for libraries to complete their sets and for persons having real need for any of the volumes to obtain the earlier ones at small cost. The remainder of the edition is distributed by the survey and the Secretary of State to institutions and individuals making application for them or exchanged with other surveys or publishing organizations.

Any of the published reports will be sent upon receipt of the amount noted. Money orders, drafts and checks should be made payable to F. W. DeWolf, Assistant State Geologist.

The topographic maps completed and published are distributed from Washington, the State having made no provision for publishing a local edition. They may be purchased at the rate of five cents each or $3.00 a hundred. Drafts or money orders should be sent to the Director, U. S. Geological Survey, Washington, D. C. He is not allowed to receive postage stamps or personal checks in payment. The areas already surveyed and the names of the maps are shown on the accompanying map.

Reports in Preparation.—There are a number of reports now ready for the printer or in an advanced stage of preparation. These include three educational bulletins which have been already submitted, and three others which are available at any time. The three which have been for some months ready for the printer are:

The Mississippi Valley between Savanna and Davenport, by J. Ernest Carman.

Physical Features of the Desplaines Valley, by James Walter Goldthwait.

Physical Geography of the East St. Louis District, by N. M. Fenneman.

The three reports which are ready to be submitted at any time are:

Physical Geography of the Springfield Quadrangle, by J. C. Jones.

The Middle Portion of the Illinois Valley, by Harlan H. Barrows.

Physiography of the Wheaton Quadrangle, by A. C. Trowbridge.

In less advanced state of preparation is the year-book for 1908, including a preliminary report on cement making material of Illinois; some studies of Illinois coals and other papers. Special reports on coal, oil and other materials are in preparation.

The State Geological Survey has not attempted as yet the publication of areal reports either by counties or districts. Instead, arrangements have been made for the U. S. Geological Survey to assume the expense of publishing the areal reports. One such report, that of J. A. Udden on the Peoria quadrangle has been completed and is in process of publication. The report of N. M. Fenneman on the St. Louis-East St. Louis quadrangle has also been submitted. The Springfield quadrangle has been surveyed and a report has been prepared by T. E. Savage. A similar report upon the Belleville-Breese quadrangles by J. A. Udden is about ready for publication. Mr. DeWolf and his assistants have surveyed a number of quadrangles in the southern coal fields and preliminary articles on certain of them will be found in Bulletin 8 of this survey. It is expected later that a combined report on the whole district will be prepared.

Expenditures.

The annual appropriation for the survey, including the topographic work, is $25,000.00. Originally $10,000.00 per year of this amount was allotted for coöperative topographic surveys. In 1907, owing to a reduction in appropriations, the U. S. Geological Survey was only able to meet an allotment of $8,000.00, and in 1908 certain new charges for administration were made against this allotment, still further reducing the Federal appropriation to $6,920.00. This has been met by an equal allotment of funds by the State. In 1908, in addition, $1,000.00 of the unexpended funds of the U. S. Geological Survey for the preceding fiscal year were available and $10,484.92 of the special appropriation made by the State for the survey and study of overflowed lands. The total funds available on January 1, 1909 are as follows:

For geologic surveys	$4,577 82
For topographic surveys	1,232 36
For drainage surveys	863 46

The detailed expenditures are listed below:

General Appropriations—		
Balance on hand Jan. 1, 1908	$ 5,306 73	
Appropriation of July 1, 1908	25,000 00	
Total available		$30,306 73
Expenditures Jan. 1, 1908, to Jan. 1, 1909—		
Salary and expenses of director	$4,027 33	
Clerical help and general office expenses	2,323 91	
Surveys and laboratory studies of coal fields	4,779 38	
Surveys of clay deposits	635 24	
Studies of cement materials	877 73	
Surveys of oil fields	969 78	
General stratigraphic studies	1,831 24	
Educational series	835 13	
Water resources	682 31	
Mineral statistics	135 00	
Special studies	144 20	
Printing expenses	1.184 01	
Miscellaneous	383 65	
Topographic surveys	5,687 64	
Total		24,496 55
Balance available Jan. 1, 1909		$5,810 18
Special appropriation for survey and study of overflowed lands—		
Balance on hand Jan. 1, 1908		$10,484 92
Expended in 1908	$9,621 46	9,621 46
Balance available Jan. 1, 1909		$863 46

RECOMMENDATIONS.

In view of the needs of the survey and the numerous demands upon it, the following recommendations are made:

1. That the present annual appropriation for the general support of the survey be increased from $25,000 to $35,000 annually. This is necessary if the reasonable demands for increased work along the lines now being pursued is to be met. In support of this recommendation, it may be pointed out that since the State Geological Survey was established, the mineral industry of the State has enormously increased. Excluding pig iron and spelter, the total output in 1904 amounted to $56,400,829.00. For the same items in 1907 the total was $93,415,404.00 and for 1909 probably an even larger amount. It is not claimed that this increase, amounting to 65 per cent, is due to the activities of the survey, though the latter doubtless had some influence. It may be pointed out, however that this increase in production has very greatly increased the work of, and demands on, the survey. At the time this bureau was established and the size of its annual appropriation fixed, there was no oil production in Illinois. We have now a production of nearly 40,000,000 barrels. This has brought millions of dollars into the State, and has also brought hundreds of requests to the office of the survey for information regarding depth to various horizons, location of anticlines, etc. It has not been possible to give satisfactory service to this industry because we have not had the men nor the money to hire them. At the completion of Mr. Blatchley's season in the oil field this year it was necessary to practically stop the work and leave the results undigested and unstudied, and therefore largely valueless, because of the pressure of routine work in the office. If the information asked for by the oil men could be promptly and accurately supplied now that they are in the mood for prospecting, very large developments would undoubtedly result. These facts are cited to illustrate the new and unanticipated demands made on the survey, which require additional funds if the work now undertaken is to go forward; to say nothing of new lines of work as yet untouched. Similar but less critical conditions obtain in regard to the demands on us for information regarding coal, stone, clay, and other minerals.

   It is further true that as the work of the Survey becomes better known and more of the citizens of the State learn the ways in which the office can be useful to them, that larger demands on the time of the members of the force are being made. This may be expected to continue and so, from time to time, either additional funds must be provided or the work deliberately cut down. In the estimate above no provision is made for taking up any new lines of work. If it is desired that any of the many which have been suggested, be taken up, a still larger increase must be made.

2. That the special appropriation of $15,000.00 for the survey of the bottom lands be continued and be made annual. While good progress has been made, it will necessarily be several years before complete plans for the proposed reclamation of these lands can be presented. It is everywhere recognized that surveys are the first step, and the maps are necessary to any satisfactory study of the problems involved, either by the engineer or the financier. These maps are now being made rapidly, accurately, and economically; at a cast, in fact, of but a few cents per acre. If any satisfactory plan of improvement is ever to be adopted it can only be on the basis of the study of the whole valley, or even of the comparative study of several valleys. The force is splendidly organized, and the work should go forward without any check until all the data needed for a comprehensive plan of action are at hand. The reclamation of these bottom lands and the regulation of the rivers is one of the big constructive problems of the State. We will never, however, make sure progress with problems of this nature except on the basis of accurate knowledge, and to this end these surveys and the coördinate work of the coöperating State bureaus should be liberally supported.

3. It is recommended that a special appropriation of $7,500 per annum be made to the Geological Commission to provide for preparing and engraving illustrations and maps for printing and binding the reports of the survey; provided that all printing contracts be approved by the State Printer Expert. The law establishing the State Geological Survey requires of it: "The preparation of geological and other necessary maps to illustrate the resources of the State" and "The preparation of reports, with necessary illustrations and maps." It is further provided that: "The regular and special reports of the said bureau shall be printed and distributed or sold, as the commissioners shall deem best." Finally there is the following section with regard to the printing:

> "SECTION 6. The printing of said reports and necessary supplies of stationery, blank books and other printed matter necessary for the purposes of said bureau shall be and form a part of the State printing contract, and as such, shall be under the direction and supervision of the Board of Commissioners of State Contracts; *provided, however,* that the cost thereof shall not exceed the sum of five thousand dollars ($5,000.00) per annum."

The reports so far issued by the Survey have been printed by the State Printer under the terms of Section 6. Despite, however, the specific provision of the law to the effect that such reports shall include maps and illustrations, the latter have been paid for out of the general support fund of the survey. At one time the paper upon which the reports were printed was paid for by the survey. There are probably good reasons for this, and there is no objection from the point of view of the Survey, provided that this expense be taken into account in fixing the appropriations of the latter. As it stands, this constitutes expense of from $1,000 to $2,000 a year, and serves by just so much to decrease the amount originally intended to be made available for the field work of the survey. So far only the most necessary maps have been published, and these have been printed in small editions. No provision has been made for publishing by the State of any of the detailed maps now being made, and much valuable material is therefore unavailable to the general public.

4. It is recommended that hereafter the reports of the survey be published in the same general style as regards typography, paper, and binding as were the reports of the older Geological Survey of Illinois, and as are now the bulletins of the State Laboratory of Natural History, and that adequate appropriations be made to the commission to cover the cost of this paper, printing and binding, so that the work may be done promptly. Section 6, quoted above should be repealed in order to relieve the Secretary of State of responsibility.

As matters now stand, even with the survey paying for all maps and furnishing all engravings to the printer, it has been impossible to get reports printed as fast as they were prepared. There are now seven reports written and ready for the printer, and several more in preparation. Some of these reports have been in hand for more than a year, and yet the survey has never had the benefit of the maximum amount allowed by law for its printing.

A list of the reports awaiting publication has already been given. All these reports have been written by the best men we could command anywhere in the United States, and each is designed to answer a specific purpose. The field work has been done and paid for and the report has been written, and yet the State has no benefit because of the congestion in the printing office and the defective arrangements already cited.

In addition to the reports enumerated, detailed reports on the geology and mineral resources of the Peoria, Springfield, Belleville-Breese areas have been prepared and material is in hand for a similar report on the southern coal fields from New Haven as far west as Herrin. As each of these reports will require an expensive, engraved map for which the State has made no provision, arrangements have been made for their publication to be undertaken by the Federal Government. It is desirable, if possible, that the State provide at least one edition of these and similar reports for local use.

Studies of the coal, cement, oil and clay industries are being prosecuted, but in the absence of adequate means of publication no attempt has been made to hurry the preparation of reports. None the less, a report on cement materials is practically complete.

These difficulties regarding printing have arisen not because of any lack of coöperation on the part of the various persons concerned, but because the attempt is being made to put out technical publications from plants designed for commercial and ordinary book work, and with facilities entirely inadequate to the demand. A change is imperative, since it is poor policy for the State to spend money on surveys and investigations and then not provide for printing the results promptly and in such form as to be really serviceable to its citizens.